Model Cars
AND
Locomotives

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with the collaboration of
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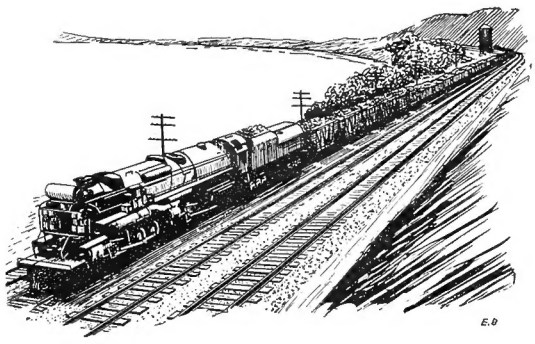

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Foreword.

The scope of this book is restricted exclusively to the popular scales adopted for indoor layouts. Live steam does not come within its scope, nor do those miniature gauges which are commonly used for garden railroads. The book deals only with power units having electrical propulsion and with rolling stock as related to those units.

This introductory note must mainly take the form of an acknowledgment of indebtedness to many experts and many published authorities on the subject. It would be quite impossible to produce such a book as this without some element of borrowing other people's ideas, for writing on miniature railroading is propaganda work, and all such effort gathers within itself the discoveries of earlier workers. Moreover, with the permission of the publisher and at my suggestion, the excellent series of locomotive articles by Frank Taylor which appeared in The Model Railroader, have been incorporated as an integral part of the book. Mr. Taylor has also collaborated in preparing the book for publication.

To others, a word of grateful acknowledgment must be offered. The manufacturers have been most helpful and encouraging in providing whatever in the nature of guidance was requested. It seems almost an invidious act to name any of these in particular, yet there are some who must be personally indicated. It was Elliott Donnelley of Scale-Models, Inc., who first suggested the book to the writer; and W. K. Walthers, George Stock, Howell Day of the Model Railroad Shop, and Linn H. Westcott of The Model Railroader have been extremely generous supporters. To A. D. Purkis, Frank Bentley, J. D. Tyler and Gordon Varney a very large debt of gratitude is due.

To the Editor of Railroad Magazine the author is deeply obligated for most kind permission to make use of some of the pen and ink sketches which regularly appear in that journal and which go far to show the excellence of the fare which it provides.

Lastly, there are a number of personal friends whose long-sustained intercourse has contributed in a measure not small to what the book contains. These include Allan Lake Rice, C. B. Russell, J. B. Caldwell and—by no means least worthy of thanks—a most hospitable and cordial publisher. Long live and greatly extend our fraternity!

—E. B.

1

Gauge, Scale, and What to Model.

THE RANGE of railroad modeling today embraces at least seven accepted standards. Their separate history, the manner in which they first came into being and the conflicts which have been waged in their respective favor is too long a story to be told here. To those who are technically interested it will already be a familiar tale requiring no repetition; for the beginner our space can be more profitably employed. The following chart gives the details of these various gauges. Model railroad scale and gauge terminology is sometimes loosely used, with consequent confusion as to what the various scales and gauges really are. The accepted values and names for each gauge are as follows: Scale is the equivalent in the model of one foot in the original, and gauge is the minimum distance between the running edges of the rails.

	Scale	Gauge
E gauge	1/8"	19/32"
HO gauge	3.5 mm.	16.5 mm.*
OO gauge	4 mm.	19 mm.†
3/16" scale	3/16"	7/8"
Q gauge	1/4"	1 3/16"
O gauge	1/4"	1 1/4"
O gauge	17/64"	1 1/4"

*N. B.—NOT 5/8".

†Almost exactly 3/4".

Fortunately for our comfort, three of the above seven standards may be relegated to secondary importance; one is a comparative newcomer, and so our main attention in this book can be concentrated upon what may be termed the "Big Three." On pages 2 and 3 we have those three most popular scales, together with 3/16" (a good intermediate size), arranged for comparison or contrast. It will thus be possible to obtain immediately a real notion as to what they are. They have been selected from the seven for the obvious reason that they are by far the most popular, and also give the best size range. Some additional remarks may bring out these points.

The Big Three.

O gauge is the scale of 1/4" to 1 ft. and has track-width or gauge of 1 1/4". It is the oldest of the now popular standards and was for many years the predominating one. Hence its enormous range of commercial components and ready-built models. Its devotees maintain that fragile details such as locomotive piping, car ladders, hand rails and so forth can be more easily constructed than in the smaller sizes. Evidences indicate that it will soon be no longer possible to claim pre-eminence for this gauge in the field of popularity. The minimum radius for O gauge, where locomotives having any modern proportions as to size are to be run, should be 5 ft., if possible, except at freight sidings.

O Gauge.

This same gauge is also used by many scale fans along with a scale-equivalent of 17/64". The reason for this is that the figure is actually more correct and precise than 1/4"; but the computation of dimensions from railroad companies' drawings will be found more difficult in the former than in the latter case. On behalf of the more accurate scale there is much to be said. The difference in the finished locomotive models is by no means slight, and the appearance of the larger scale gives a better look to finished work. Notably is this true of the driving gear, since there is 1/32" more on each side for the rods and valve motion.

OO Gauge.

OO gauge is the scale of 4 mm. to 1 ft. and its track gauge is 19 mm. There are several firms who handle it exclusively. In its present stage it may be viewed as something between HO gauge and O gauge, but its lack of popularity is possibly due to the fact that the contrast with O gauge is not sufficiently pronounced, as it is in HO gauge. Curves ought to be at least 4 ft. radius.

The American OO gauge must not be confused with the British standard of the same title. It is really a definite departure from the British scale, which used 3.5 mm. Its main object was really to provide a slightly increased accommodation for mechanism, and more detail. Those who advocate OO gauge today do so mainly on the basis of increased power obtainable in the slightly larger motor; yet it is unlikely that this argument will much longer apply, as there have been so many improvements in the smaller mechanisms.

HO Gauge.

HO gauge has a scale of 3.5 mm. to 1 ft. adopting a track width of 16.5 mm. It is the smallest of the "Big Three," and, as its initials indicate, it is allegedly "Half O." Broadly, this claim is correct, yet it must not be accepted literally. HO is only "Half O" if O gauge is understood as representing a scale of about $^{17}/_{64}$". Drawings in this and other books are frequently given to a scale of ⅛" to 1 ft.; this is just one-half the size of models designed to the ¼" scale. But in order to bring these dimensions to the correct HO gauge size it is necessary to add 10 per cent. Freight cars which in HO would be 5" to 6" long would in the popular O gauge be about 10". HO gauge has the real advantage of being the cheapest generally-accepted scale in which to work. Curves should not be sharper than 3 ft. radius for the main line. It could be soundly argued until recently that this scale provided scanty detail and poor running, but both these statements are now entirely out of date. And, of course, the strongest point about HO is that it offers genuine scope for really representative features of layout, in which docks, factories, depots and locomotive shops can be fully and faithfully modeled.

Three-sixteenths inch is a comparatively new scale, having for its track width ⅞". It has a certain definite popularity though it is the manufacturing perquisite of only one firm. As will later be discovered in

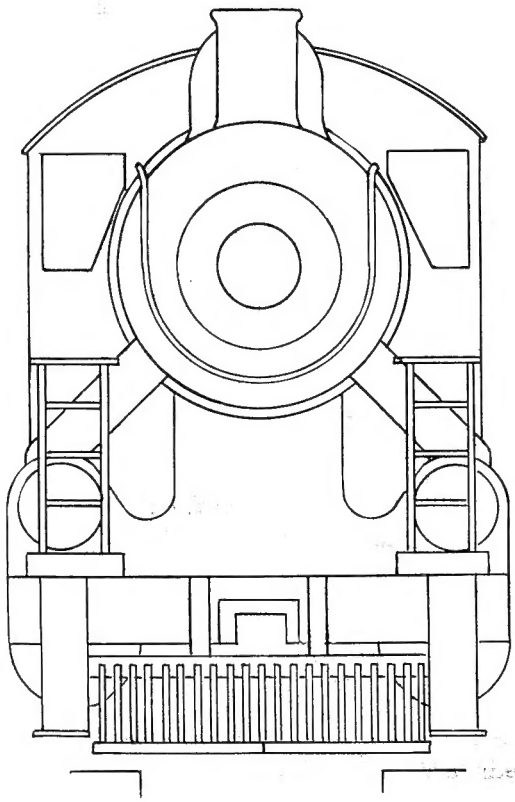
The popular scales at a glance—

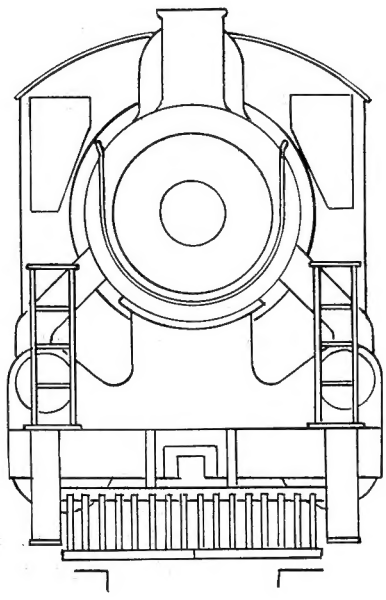
Largest is O gauge, 1¼" between rails, using ¼" or $^{17}/_{64}$" scale. Q gauge is also ¼" scale but rails are $1\frac{3}{16}$" apart.

$\frac{3}{16}$" scale with its ⅞" gauge.

OO gauge, 4 mm. scale gauge is 19 mm.

HO (16.5 mm.) gauge 3.5 mm. scale is the smallest commonly used size.





these pages, its structural methods differ rather profoundly from all other standards, though some very satisfactory and attractive models are produced. Its advocates claim that, although it is smaller than O gauge, and offers all the advantages lying in that fact, it is not too small for the average amateur to handle and construct, and it provides ample accommodation for power.

Three-Sixteenths Inch Scale.

E gauge and Q gauge have interesting features but are only championed by a few enthusiasts. E gauge fans will find it a convenience that many drawings are here produced, for other reasons, to ⅛″ scale. The main reason for the Q gauge is that it provides with the ¼″ scale the precisely correct track width, with the realistic overhang of stock thus secured.

The National Model Railroad Association, known briefly as the N. M. R. A., met in 1935 and carried out an excellent piece of work in laying down certain bona fide standards relative to the accepted scales. It had taken nine years for this group of authorities to get together and agree upon a certain uniformity. They fortunately enjoyed the cooperation of a large number of manufacturing firms. For the sake of a reasonable unity, sacrifices and renunciation of prejudices were made on all sides. In subsequent years the Convention has met in order to consolidate and extend its work. Very shortly after its first meeting the newly formed association was formally accepted by the Association of American Railroads. On page 8 is a table setting forth these standards, with one or two accepted additions, as they affect locomotive and car design of the popular scales. The table appears to need no exposition at this point.

The N. M. R. A.

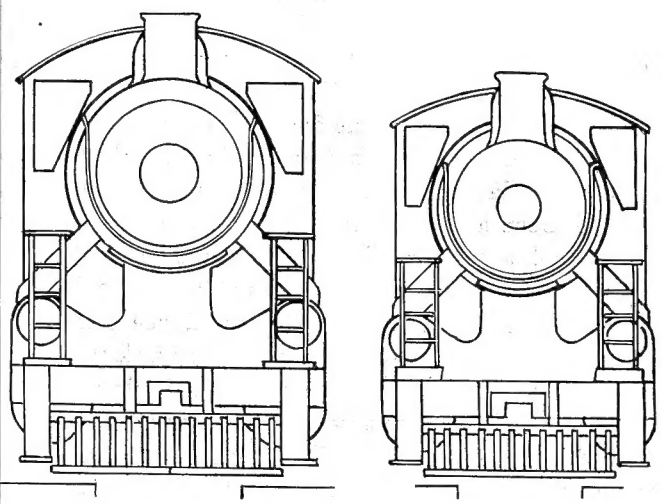
The beginner may be interested in a statement as to the probable proportions of enthusiasts who adopt the respective scales in America. Each year The Model Railroader conducts a poll or questionnaire on the subject, inviting its readers to send in statements of their preferences and general ideas. So far as scale itself is concerned, the movement during past years has been steadily toward the smaller sizes. The graph on page 7 clearly shows the year to year change.

Enthusiasts Classified.

The locomotive stud or lineup of a model pike deserves serious consideration even if only one engine can for the time being be acquired. Sooner or later there will be more than one, no doubt; but even the acquisition of the one ought to be fitted into a well thought-out plan, which should cover the future activities of the road. One advantage which the model locomotive enthusiast possesses over the actual locomotive designer is that he can choose to add out-of-date units, even historic models, to his stud. A few engine types ranging around the 1910 period, and of subsequent date, will certainly not be out of place. Locomotives of certain wheel arrangements are more or less confined to definite forms of service. It may be as well for us to begin by studying a wheel-chart and defining some of them.

Starting the Locomotive Stud.

The accepted nomenclature of American engine types known as Whyte's Classification is shown on page 7. As will be seen, these embrace (1) switching engines used for handling cars in yards, (2) articulated locomotives employed in freight and pusher service and in hump yards, as well as, lately, in heavy passenger work, (3) tank engines, rapidly dying out of use, but still employed in switching and suburban serv-



ice, (4) locomotives having two-wheel leading trucks and employed mainly for freight service, and (5) engines with four-wheel leading trucks, mainly used, but not always, in passenger work. Where several units are to be employed on a layout it will perhaps be well to have a switcher, a passenger engine of the lighter kind and one of the heavier, a main line freight hog, and maybe a suburban tank engine. On the other hand, a great deal will depend upon the particular business which the layout claims to furnish.

Some roads are Mikado roads, depending mainly on that type of power because the traffic is mainly heavy freight. Others look to the Berkshire or the Santa Fe for most of their freight hauling. Some roads, like the Pennsylvania, use the Pacific for nearly all their passenger work. Others have a wide variety of passenger power. Atlantics can be seen on 12-car trains and Hudsons on 3-car trains. This remark may serve to overcome the hesitation experienced by certain amateurs as to whether for their short trains they ought to provide large modern engines or not. It is not unusual to see an enormous freight hog, designed for hauling 150 cars, crawling along the main line with 20; also, Pacifics sometimes pull freight; Mikados haul passenger trains. It is often more economical to use a heavy engine, if available, on a light train than to use the more appropriate looking light engine. It might be much the same on a model pike. On the Ohio State Limited, it is the usual thing to put a Hudson at the head of only eight cars; Norfolk and Western Mountain types haul occasional expresses with only six cars; the Pennsylvania uses a K-4 Pacific to haul a morning train out of Pittsburgh with only three, and the C&O morning train out of Cincinnati has only two cars behind a light Pacific. Nor is it an uncommon sight to see fewer than 20 cars behind a Mallet. On the other hand, of course, some roads rarely run fewer than 15 or 20 Pullmans behind a Hudson. Much depends on the prevailing grade of the system, much also upon the whims and fluctuations of traffic.

All this does not mean that it does not matter what type of engine is chosen for a layout. The stock should be representative and should serve generally its proper functions. Only if a road is limited in its stud does the question become comparatively unimportant. Then the same light engine may serve for both passenger and freight, or for locals and switching. Other types, like the 4-8-4, are designed for mixed traffic. On any actual road, again, it will be found that certain units date back as far as 40 years, a profitable suggestion for the model builder. There still is something tremendously fascinating about the tall-stacked Ten-Wheeler, not to mention the Mother Hubbard. Your stud may also include old engines brought up to date by the addition of modern gadgets; two Pacifics otherwise of the same class may be modified and varied in this way.

It may be that the passenger work, or even the entire service of the layout, will be dealt with by the electric type locomotives, fitted with trolleys to use the catenary system of power supply, though on a free lance layout this always appears to the writer to be a needless sacrifice of steam-outline engines. It is well to bear in mind that steam type engines are commonly run on main lines that are equipped in this manner. Suburban passenger work only may be handled by multiple-unit electric trains, while freight and through passenger service is dealt with by steam locomotives.

Prototype Modeling versus Free Lance Modeling.

This really brings us to the decisive question as to whether the layout is to represent an actually existing company or merely a section of such an actual road, or whether it is to take the free lance form absolutely. Prototype modeling has its definite attractions within limits. Let no one attempt to disparage the free lance idea on the argument that it is better to stick utterly to true scale throughout, for no worker has ever yet been able to do this. One may set out to model a section of some stated company's route, but it will be no more entirely to scale when finished than a well-executed free lance layout. If the engines are right the track will be wrong; or, if both are right, the buildings will give the game away. Or if these are perfectly sound, what shall be said of the scenery? Moreover, where a certain railroad's

Locomotive and train on the Mountain Division of the Union Connecting RR. (old line) of the New York Society of Model Engineers.

system is modeled, the builder must beware of glaring incongruities such as mingling Western clearances with Eastern, which are much more restricted, or running a Pennsy K-4 along with a Southern Pacific oil burning Mallet with its cab out in front and the boiler facing the tender. A Milwaukee Road Hudson and an NYC Hudson are both 4-6-4's but the similarity ends there.

These, and scores of similar pitfalls, are the problems of the fan who wants to model after one particular railroad.

Free lance articulated locomotive made from a Varney 2-8-8-4 boiler and two 4-6-2 chassis by Thomas Wright, Los Angeles.

The Model Railroader ballots already mentioned show that the range of free lance modeling is also increasing with the years, though in 1938 there was possibly a slight falling off. But beyond question free lance modeling does offer enormous attractions. It can embrace all that is found fascinating and desirable, being faithful to general principles though bound to none in especial. Free lance modeling does not mean modeling without principles; if it ever does mean that it is to be ruthlessly condemned. What it really involves is a much broader and more general knowledge of what the real principles are. The true criterion was recently laid down clearly by the Editor of The Model Railroader in these terms: "If this same design were followed in full scale, would it meet the requirements of service on such a line as the free lance road represents?" Suppose we build a model pike between two imaginary points known as Dry Gulch (a main line depot) and Powder Creek (a mining center) with a 50-mile main line be-

Free Lance Advantages.

tween. We stake out the railroad through the rough intervening country, adhering to a maximum grade and minimum curvature. We line up prospective traffic and figure out the trains necessary to haul it.

Does it follow that from that point we go on to outrage every known standard of real procedure? Not at all. The builder must have "real practice" reason for everything he does, sticking to the book even to the extent of axle loads and clearance gauge. But he may embrace in his survey the procedure of all the recognized systems. If he wants to have a Mallet he may, though he may definitely *not* have one if he is modeling all of his power, type for type, after a railroad that does not use Mallets. If he wishes to stick to initials which are readily obtainable, for his lettering, he may do so by seeing that the name of his imaginary system starts with the same initials as some real railroad. The same thing applies to established colors. Or, he may install an electric suburban branch, a narrow gauge subsidiary, a logging line or a couple or trio of linked roads. And what about foreign countries and their provision for railroad modeling? Nothing is more natural than that the American should conclude that he has no need to go beyond his own land for anything he may require; that statement is, fortunately enough, true. But it is worth while to remark that there are countries where a combination of British, German, Russian and American types have been pressed into service. The writer has seen American Mallets in Africa and American Mikados in Jamaica side by side with British Ten-Wheelers, the Buckeye coupler being used as standard. Whether we restrict modeling to the practice of one country to the exclusion of all others is purely an artistic question and by no means an engineering one.

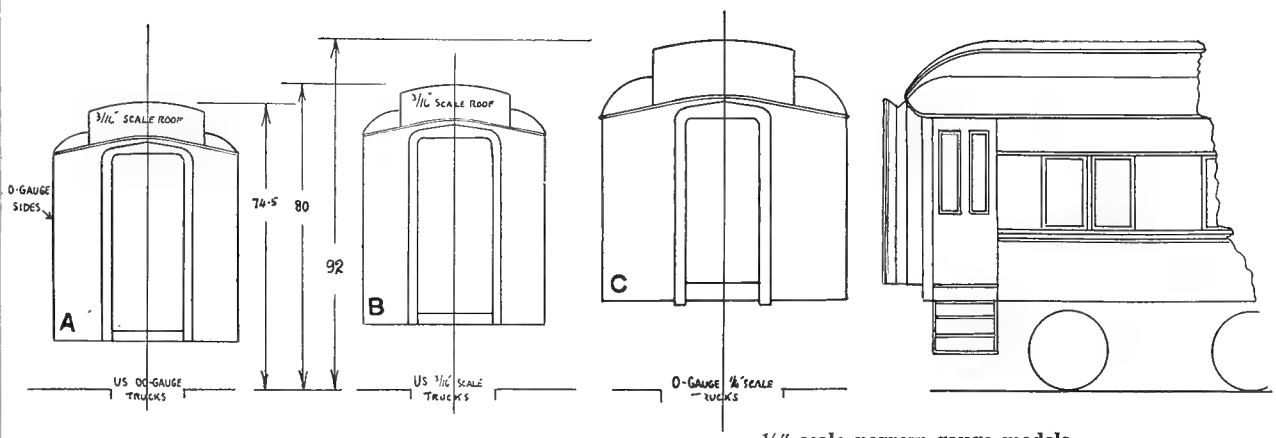
In fact, the writer himself would poll for free lance work if only on the one point of narrow gauge modeling, taken as a subsidiary of some standard gauge. It offers an enormously extended scope. Consider the new layout of the New York Society of Model Engineers. This covers a right of way 80 x 120 ft. approximately, and includes an extremely interesting group of arrangements that could not be found on any one railroad. The main engine terminal is some distance outside the city, so that trains may be run into the city itself by electric type engines. A trolley line will be incorporated in the city. The main road is O gauge, and there is a subsidiary narrow gauge route to a standard of 3 ft. for which OO gauge tracks are used. It will thus be possible, on certain stretches of this subsidiary, to run either narrow gauge stock for the O gauge route or actual OO gauge stock. On the New York club's layout now dismantled there was such a narrow gauge road.

Narrow Gauge.

One advantage in the diversity of the different small gauge standards lies in the important fact, generally overlooked, that they can be made to subserve each other in this manner. On the next page, as an example, we have some suggestions regarding the outstanding dimensions for this kind of scheme. The top right hand diagrams C indicate the ends of a passenger car in O gauge; the two diagrams A and B show possible standards for narrow gauge cars to suit the same standards. In A we have what may be regarded as a minimum clearance in conjunction with head space to accommodate scale passengers. The track gauge here would be 19 mm. or OO gauge; coach sides would be O gauge; trucks would be OO; roofs might be ⅞", or specially made. In the style of B, the track itself ⅞" gauge and the trucks likewise, as well as the roof. In A, therefore, the minimum track radius would be 3 ft.; in B, 3'-6".

Some Instances.

On an OO gauge system, similarly, the narrow gauge might be HO, using trucks and track of that standard with the upright components of the larger scale. A locomotive of the narrow gauge type to ¼" scale might use a ⅞" gauge mechanism or even a OO gauge motor with ¼" scale parts. By using various cabs, boilers, and fittings, a great number of interesting narrow gauge locomotives may be built. On an HO gauge layout it might even be possible to work in some British OO gauge coach printed sides for narrow gauge passenger stock. A tiny engine could be modeled by installing the motor in the tender.

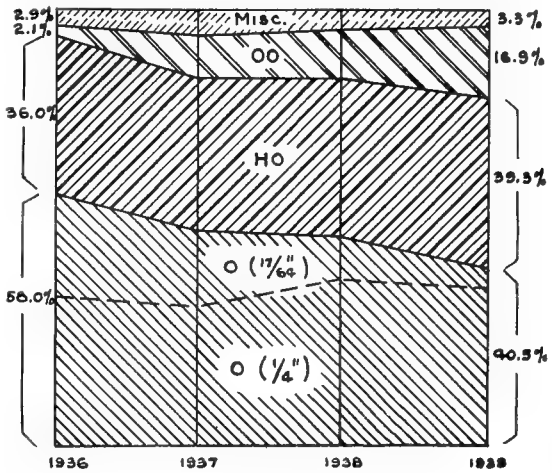


¼" scale narrow gauge models.

A few words at this stage as to cost. Due to the number of gauges and the variety of kits offered, the cost of model railroading is an extremely flexible item. One enthusiast may be merely a collector of builtup railroad models. Another may insist upon making everything himself. The second is the gainer financially, though aesthetically he may be the loser. On the other hand, he may not. All depends upon the kind of work he does. One man, again, may work with kits—and what a galaxy of choice he has before him today!—and another may do his own construction, casting, turning, or whatever it may be. A kit for a perfect little HO freight car costs a dollar; a ready built locomotive of the same scale may cost $75. Or, again, one may be had that is a beautiful piece of work for about $25. The thing for every enthusiast to do is to suit his craft to his purse; whatever way he goes, he will get just as much pleasure out of his task.

The Question of Cost.

THE TREND TOWARD SMALLER GAUGES



The above graph shows the changes in gauge popularity during the four years The Model Railroader has been taking its prototype poll. (From Model Railroader's June, 1939, report.)

Switching Locomotives

0-4-0	4-Wheel Switch
0-6-0	6-Wheel Switch
0-8-0	8-Wheel Switch
0-10-0	10-Wheel Switch

Locomotives with 2-Wheel Leading Trucks

2-4-0	4-Coupled
2-4-2	Columbia
2-6-0	Mogul
2-6-2	Prairie
2-8-6	Consolidation
2-8-2	Mikado
2-8-4	Berkshire
2-10-0	Decapod
2-10-2	Santa Fe
2-10-4	Texas

Locomotives with 4-Wheel Leading Trucks

4-4-0	8-Wheel
4-4-2	Atlantic
4-6-0	10-Wheel
4-6-2	Pacific
4-6-4	Hudson
4-8-0	12-Wheel
4-8-2	Mountain
4-8-4	
4-10-0	Mastodon
4-10-2	
4-12-2	

NATIONAL MODEL RAILROAD ASSOCIATION

STANDARDS INCLUDING ADDITIONS MADE AT THE NATIONAL CONVENTION, SEPT. 5, 1938

Watch advertising for this emblem:

Indicating equipment built to these standards.

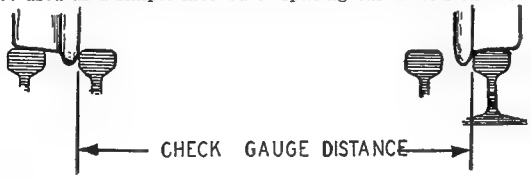
Name of gauge Dimensions in this chart given in	O Inches	OO mm.	HO mm.
Track gauge This dimension is the minimum allowing for widening on curves.	1¼	19.00	16.50
Scale	¼ or 17/64	4.00	3.50
Maximum flange thickness	3/64	.75	.75
Maximum flange depth	1/16	1.00	.75
Check gauge distance *	1 11/64	17.75	15.25
Back to back of flanges †	1⅛	17.00	14.50
Tread width (minimum)	⅛	2.00	1.75
Flangeways (frog and guard) ‡ This is the minimum and should be used except where a small radius curve requires special allowances.	5/64	1.25	1.25
Third rail above running rail	⅛	2.00	1.50
Third rail center out from gauge These dimensions should be as accurate as possible.	11/16	10.00	8.00
Third rail shoe over all length	3 to 3⅛		
Third rail shoe spacing (minimum)	10	150.00	125.00
Center of couplers from rail This is also an accurate dimension.	¾	11.50	10.00
Minimum switch This applies to a turnout from straight track. Special work radii shall not be less than used with a No. 6 turnout.	No. 6	No. 6	No. 6
Minimum radius curve ‡ Applies to all main line track where interchange with any equipment is desirable. Yard and industrial trackage may of course be built to suit the home equipment. Recommended that builders specify what minimum radius their product will negotiate.	5′	3′	2′

Standards for other gauges available on request. Write H. E. Bondurant, Chairman Engineering Committee, 2327 N. 70th St., Wauwatosa, Wis.

Locomotives shall be compared by determining their drawbar pull at a standard voltage. Gear ratio and driver diameter shall also be stated. For O gauge, 12 volts D. C. or 16 volts 60-cycle A. C. shall be used as the standard. For HO gauge, 6 volts D. C. shall be used as standard. For efficiency comparison, the current through the motor should also be measured.

When using polarized control, positive potential on the third rail, trolley wire, or right hand rail shall produce forward motion. Rear coupler insulated shall be standard for two-rail locomotives so that they may be double-headed.

† The back-to-back dimension is here mentioned as being the common method which has been used to check wheels for standard. This dimension will still be the same when the other measurements are closely adhered to and may still be used as a simple method of spacing car wheels on axles.



* This dimension (see illustration) is the maximum when applied to wheels and the minimum when applied to track.

‡ We suggest that in case difficulty is experienced with long wheelbase locos on sharp curves (such as under 6 ft. in O gauge), and where guard rails are used on both sides, as in special work, the following ideas be borrowed from the prototype:

a. Make gauge of front and rear drivers slightly less by spacing them closer back to back.
b. Cut flanges off center drivers.
c. Allow some lateral movement in driver axles.

Track gauge may also be slightly widened and flangeways correspondingly widened, retaining the same check gauge measurement, however.

2

The Locomotive Market.

HAVING settled the question of the scale in which he is to work, and having possibly laid a considerable section of the track work, the next matter for the beginner to decide will be the method of acquiring the first locomotive. Shall it be purchased outright in completed form, shall it be completely built up, or made up from a kit? If the purse will allow it, it is perhaps the wiser course to buy the first unit ready-built, or, failing this, to obtain a kit in which the bulk of the difficult work has been carried out. By obtaining a finished engine the amateur will discover for the first time exactly what a miniature locomotive is and how it is made, so that when he wishes to build one in his own shops later on he will know the lines on which to proceed. The multifarious and intricate details of the structure, the running gear and the mechanism will thus gradually become familiar to him. As the need of light repairs will arise in course of time, and as the owner is a novice in these matters, it is furthermore a good scheme to buy only a medium-priced outfit for a start. Any expensive engine might suffer considerably at the hands of a beginner when the various adjustments are to be made, or the superstructure removed and re-assembled. The buying of a low-priced unit as a maiden venture is also advisable even though the matter of price may have some bearing upon the type of engine selected: switcher, Ten-Wheeler, or Atlantic. This is not to say that the cheapest specimen obtainable should at once be bought. Judicious consideration and inspection of the manufacturers' catalogs should be first indulged in. Then, when the owner has cut his mechanical engineer's teeth, he may naturally be prompted to go in for something more elaborate and costly, or to set out to build something not obtainable on the market.

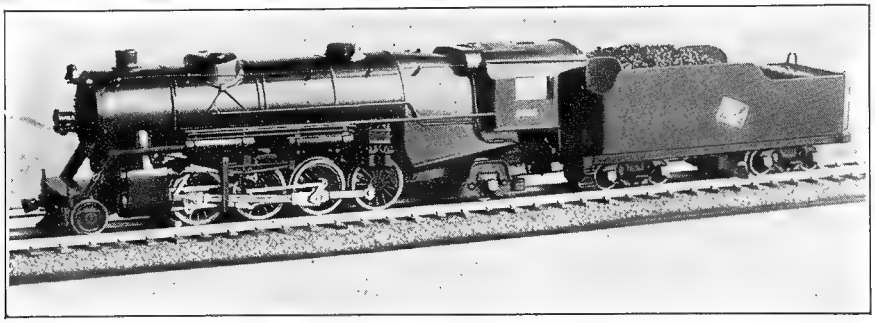
How to Acquire a Locomotive.

The various commercial houses that cater to the enthusiast have certainly excelled themselves in the locomotive material they have provided. Speaking without the slightest bias, the writer would not hesitate to say that they deserve the utmost congratulation for their workmanship, which is not surpassed, even if it has been approached by the average output of any other country. They have lavished ingenuity upon their job; they have been progressive where others have feared to launch out, and they have given to the public models of efficient and robust construction. No doubt in this task they largely benefited by the experiments and arduous pioneering of the British and European craftsmen, but the fact of their triumph remains.

Excellence of Commercial Products.

Let us get back to the matter of obtaining the first power unit for the layout. And at once we are faced with a striking fact. Whilst there are scores of engine types that may be had in all gauges in kit form, there are really not very many that can be described as ready-built. Especially does this apply to O gauge. The plain fact is that the kit method of construction is such a real pleasure that the modeling public has evidently shown it dislikes to be deprived of its fun. Most firms would, of course, be glad enough to produce any one of their kits completed to a special order and do in some cases,

Ready-Built Models.



U. S. R. A. 2-8-2 Heavy Mikado O gauge locomotive produced by W. K. Walthers, Inc.

but the cost is beyond the average modeler's ability to pay. And there are certain manufacturers who do not undertake completed work at all. In the smallest scales this difficulty does not exist in so great a measure. But in O gauge, firms like Scale-Models Inc. and Hawk Models deal almost exclusively in kits.

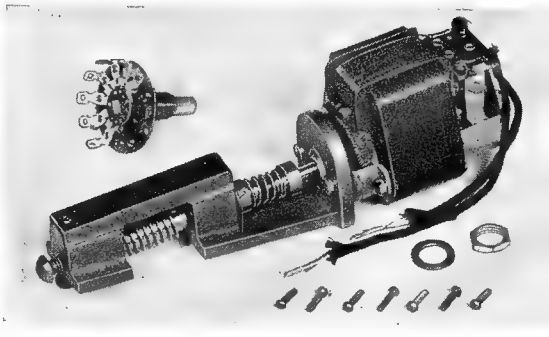
O Gauge Finished Models.

An excellent example of a completed model is the U. S. R. A. Mikado by Walthers of Milwaukee. This has split bearings which fit around the axles and into slots in the main frame, and can easily be replaced when worn. The drivers are quartered and the gears are of bakelite and steel. Main and side rods are die cast and valve-gear rods are of plated brass; the smokebox front is a machined casting. The kit includes an assembled boiler, fire box and cab with running boards and the details for the superstructure include as well as the usual boiler mountings an air pump, water pump, stoker, roof vents, tanks, turret, power reverse, safety valves, generator, inspirator, whistle, bell, marker lights, headlight and the usual piping.

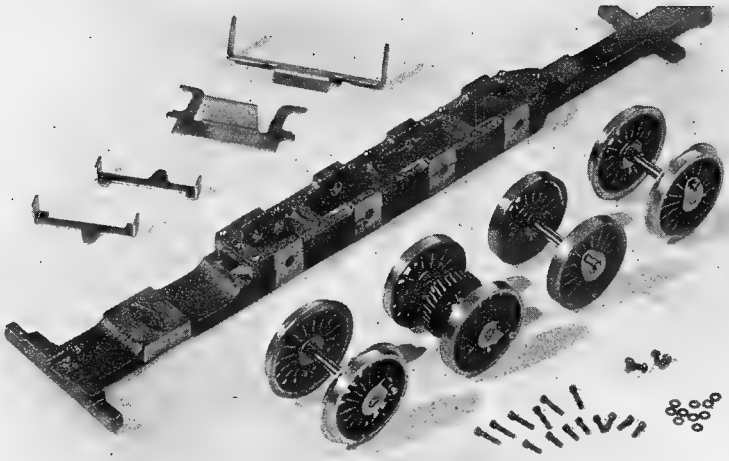
Lobaugh of San Francisco offers an exceptional heavy engine, the Union Pacific Challenger type 4-6-6-4 articulated locomotive. In the prototype this engine pulls both fast freight and heavy passenger trains. Lobaugh also builds finished locomotives of various Southern Pacific types. Icken Model Locomotive Co., Palisades Park, N. J., is one of the earliest O gauge modelers in the United States, having entered the field commercially in 1927, and will build almost any type of engine to order and with beautiful detail. American Model Railroad Co., New Rochelle, N. Y., is another firm with long experience in the O gauge field and it can supply not only kits but builtup models for a wide variety of Eastern types.

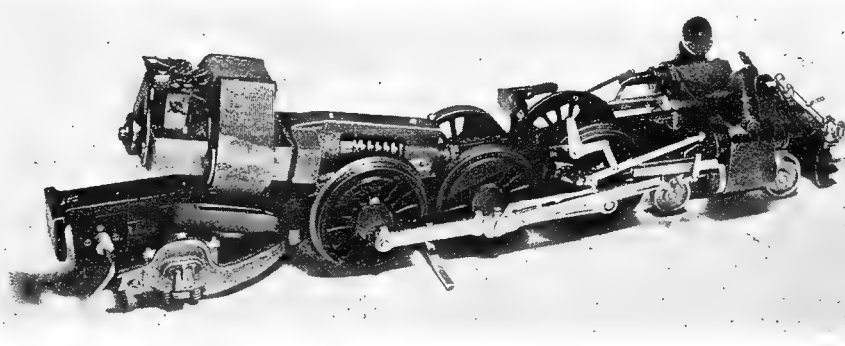
Lionel Hudson.

Among the models of the mass production type, obtainable for this reason at a much lower price, the most arresting example in recent months is the NYC Hudson offered by the Lionel Corporation of New York. This firm is an old one in the tinplate field and the Hudson is its first offering of scale equipment. The finished product is an extremely imposing and very perfect model. The engine has all its outstanding parts die cast of zinc base alloy and is powered by a heavy duty motor with a gear ratio of 10:1. Oilless bearings are used, the piping is of stainless



To the right and at bottom of facing page. Scale-Models parts to make finished chassis shown below to the right.





steel and the rodding is chromium plated. It is built for remote control and works off a special transformer at 15 volts A. C. It is also fitted with a remote control whistle. The pilot is furnished with a drop-type coupler complete with raising mechanism and tiny link chain for the uncoupling lever. Valve gear is minutely and strongly executed and the smoke box has a hinged door. The Baker valve gear is very complete. The cab roof is furnished with three dummy vents having grooved slides, and the turret on the fire box is very detailed. The engine cab, fire box, and boiler is die cast in one piece with all the rivets and bolts in their places. Seamless steel tires are pressed onto die cast drive wheels; side rods are die cast with bronze bearing inserts and the boiler details are very complete and full of realism. Lavish detail has also been put into the tender trucks which are of the correct type. The various pictures of this excellent and low priced unit will speak for themselves. The Lionel Corporation claim that it will operate on standard O gauge track using scale rail and will take switches without trouble. Scale Model Railways of Huntington, Ind., has a large variety of locomotives and cars in O gauge, one of which is illustrated.

OO Gauge Finished Models.

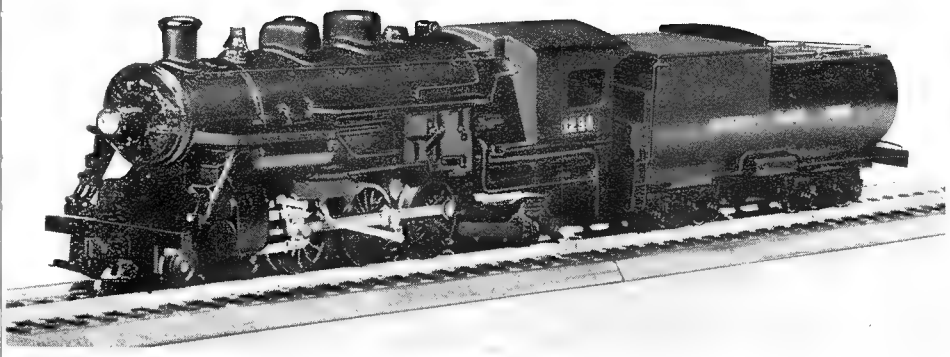
In OO gauge there is a fine New York Central Hudson type by Nason Railways as well as a Lionel reduction of their O gauge job. The Nason one is really a kit model, but it may be had completed at prices depending upon the amount of detail included. The engine and tender measures 15¼″ over all and the height of the loco-

American Standard (4-4-0) locomotive and car. American Model RR. Co.

Parts to finish a Scale-Model locomotive.

motive at the stack is 2⅜". The boiler is a detailed bronze casting that includes running boards, stack, steam and sand domes, feedwater heater, air tanks and turret. The cab is cast in five pieces. The tender is also in cast bronze. The motor is the standard Nason type for either A. C. or D. C.

There are also good locomotives in OO gauge by Scale-Models Inc., of Chicago, which has the die cast superstructure nicely detailed. It is fitted with a seven-pole permanent magnet motor operating on 24 volts D. C. and it has a modified form of Baker valve gear. Any finish or lettering can be supplied. This engine, however, has been somewhat improved upon by the Pacific just put on the market as a complete unit. Alternatively this engine may be had in kits. Complete with its Vanderbilt tender, an SP model, the machine measures 15¾" in length, and any finish can be supplied. The same power unit is used in this model and is used to drive on two pairs of wheels; there is an operating headlight fed by a flashlight battery. The current is supplied on the two-rail models through the wheels, the positive from the engine and the negative from the tender. Opposite each pick up wheel is an insulated one. Under test, this little engine, which has an absurdedly low selling figure, hauled 30 standard



One of Scale-Models OO gauge locomotives.

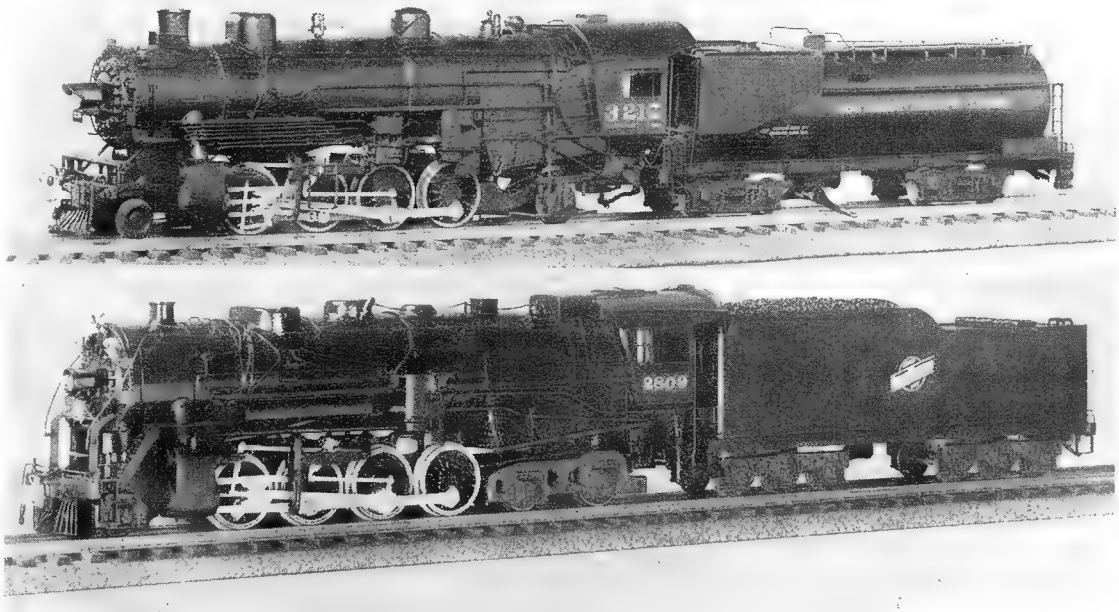
cars around a 26″ radius curve. The popular and low priced Atlantic type of Star-Continental is now made by Nason and is very close to a Pennsylvania E-6 design.

Coming down to HO gauge the variety is much more pronounced. Popular among finished models in this scale are those produced by Varney of Hollywood.

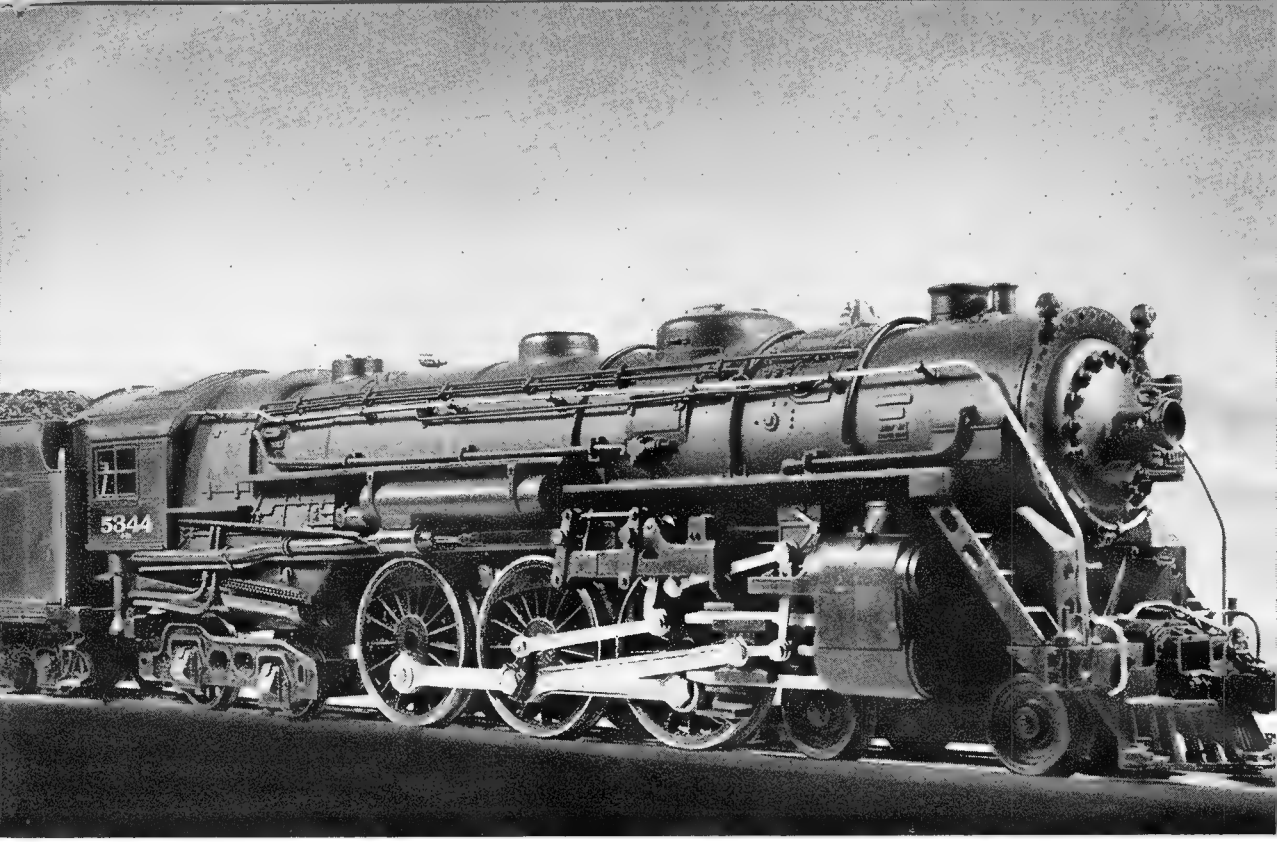
HO Gauge Ready-Builts.

There is a complete series, including a Pacific, a Consolidation, a Mikado and—unique in the field of HO gauge modeling—a Northern Pacific Yellowstone Mallet of the 2-8-8-4 wheel arrangement. Identical in structure, the first two engines have many astounding features. For one thing, the driving wheels are individually sprung, insuring that at all times each wheel is gripping the rail. The mechanism is extremely good, and has a beautiful starting and slow-speed movement as well as fast speed. The side rods are built for wear and are knuckled. Beautifully clean die cast fittings are used throughout the construction, every rivet and bolt head being included. The magnet of the motor is the General Electric new "Alnico" made in the finest magnet steel. Bearings are renewable and wick-fed. Gearing is about 40:1, and under test the engine hauled 30 freight cars over a 5 per cent grade, with over 45 cars on the level.

Mantua Metal Products Co. of Woodbury Heights, N. J., has two very good ready-builts, a Pacific and an Atlantic. There is also an earlier and quite sound Consolidation. All parts are fully machined; motors are



Mikado and Berkshire type locomotives of excellent workmanship. Rollin M. Lobaugh.

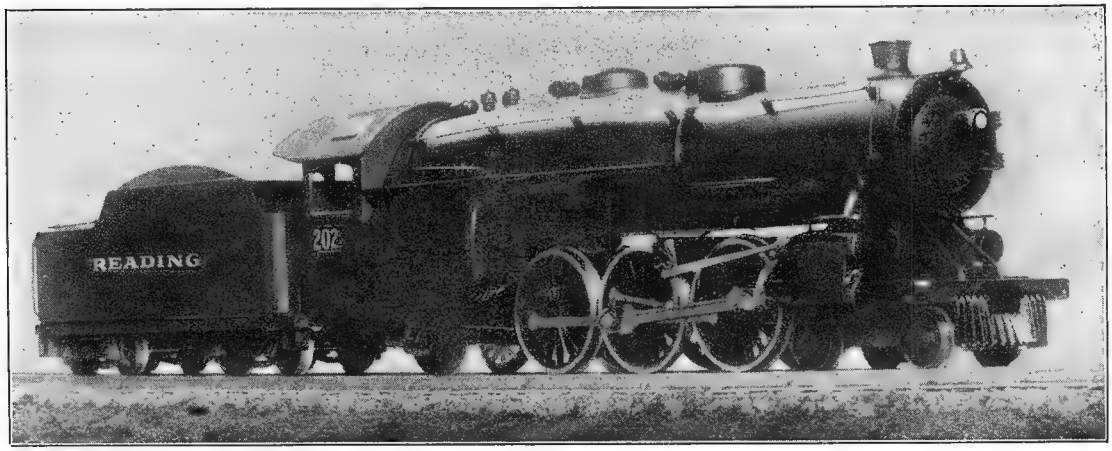


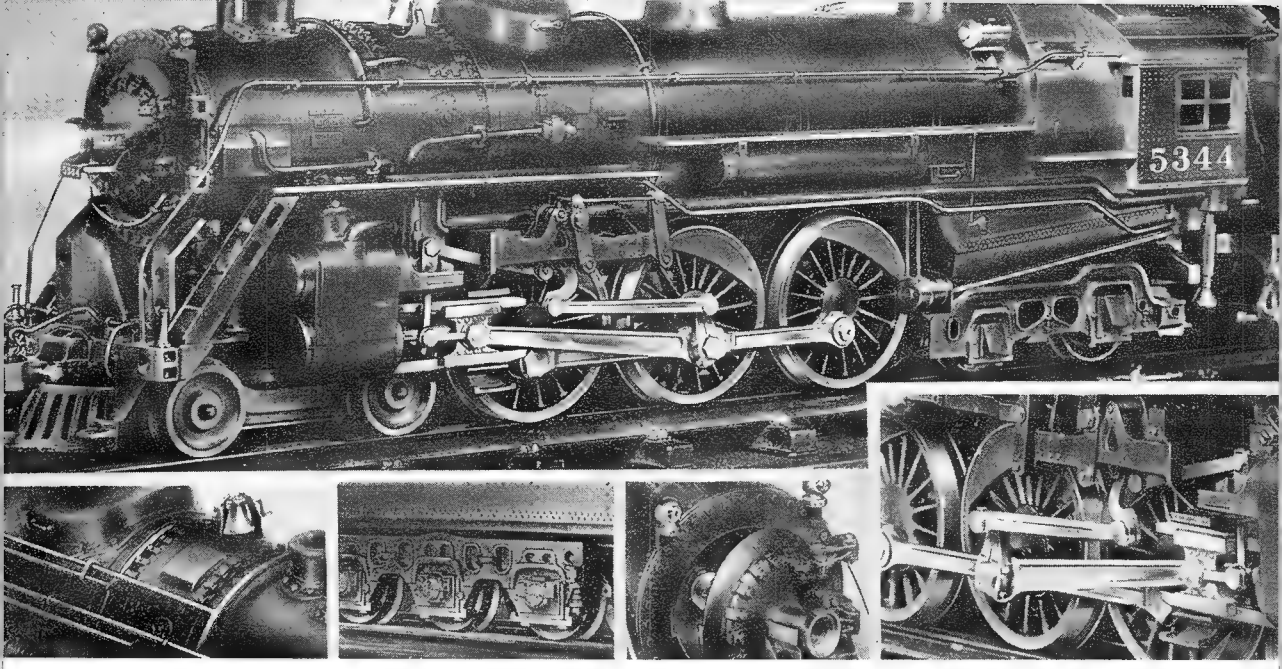
worm driven. The motor is the firm's Dual Gauge type, which is so powerful that it is fitted regularly to OO gauge as well as HO gauge units. Illustrations of these engines will be found in the text. Another low priced and really very acceptable model is the Pennsylvania K-4 by the Model Railroad Shop of Dunellen, N. J. The permanent magnet motor of this engine drives through a brass worm and fiber gear. It can be supplied for either two- or three-rail operation, and it will traverse curves of 20″ radius. Main frames are made of brass channel and wheels are of the British Cimco type, removable by turning screws. George Stock, Philadelphia, builds fine HO locos of various types to order. The A. C. Gilbert Co. has a Hudson type with A. C. series motor in the low price class.

Mantua's HO gauge Pacific locomotive.

The Kit System.

It will naturally come about, of course, before the beginner has owned a model locomotive of any sort for long, that he will desire to own others, particularly if his layout is at all an ambitious one. But he will probably feel that the financial outlay on completed examples will be too heavy to sustain. His instinct and desire will therefore be to



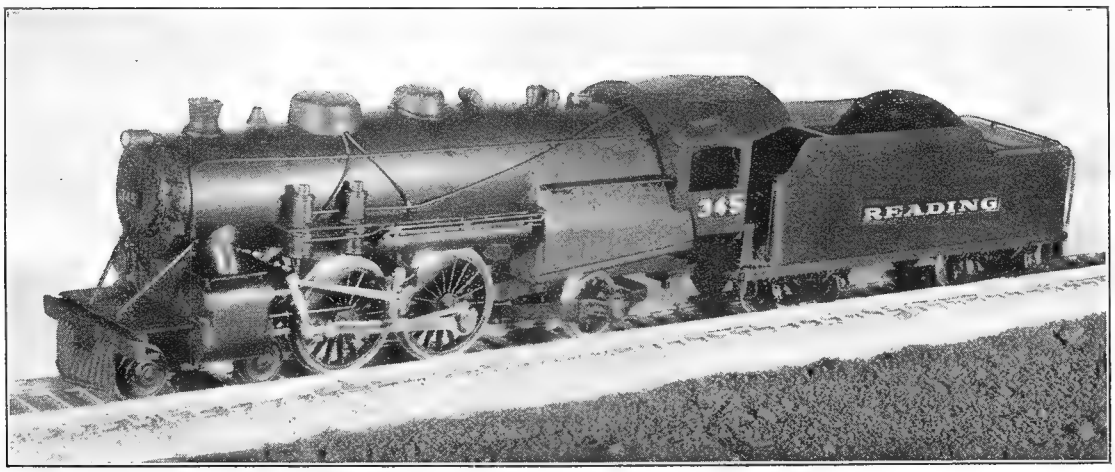


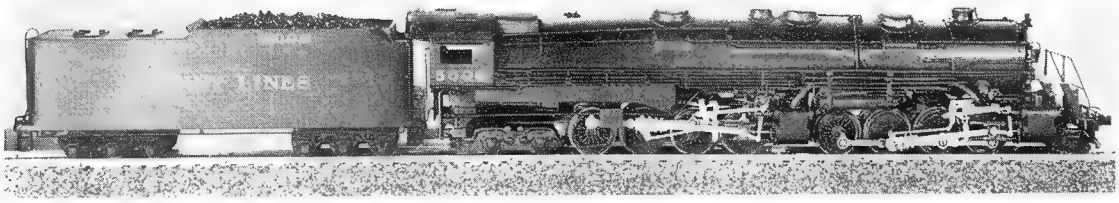
Right and left side views of Lionel Hudson and some of the detail incorporated.

obtain his stud in some cheaper way, and he will no doubt begin to consider the possibility of building for himself. It is here that he will at once see the benefit of the kit system of building, which is encouraged by the majority of the firms. All of the examples that have already been described can also be had in kit form. But there are also scores of others which are furnished in this way. The several firms have their respective methods of supplying these kits, depending upon the materials from which the models are built. Thus, some are sent out as "casting kits" in which various items are for the larger part in rough casting form which requires machining, cleaning and finishing with files or emery. Others have most of their parts ready finished, and some of them are even ready provided with the holes drilled and tapped. Some of the firms supply loose castings still requiring to be cleaned for all parts excepting the mechanisms, these being (if desired) finished before being sent out; these are called "finished mechanism kits." Many houses have a way of arranging their kits in so many sections—four or five to complete the entire structure—and these can often be bought individually so that the expense may be spread over a greater period. These are often called "sectionalized kits."

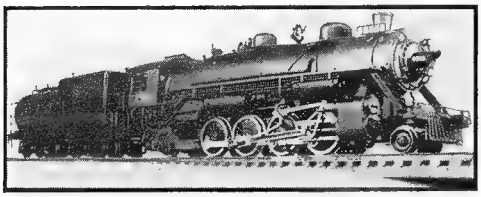
But all locomotive kits are fundamentally alike in that they furnish all the necessary parts, right down to the last screw, the paint

Atlantic type locomotive—Mantua.

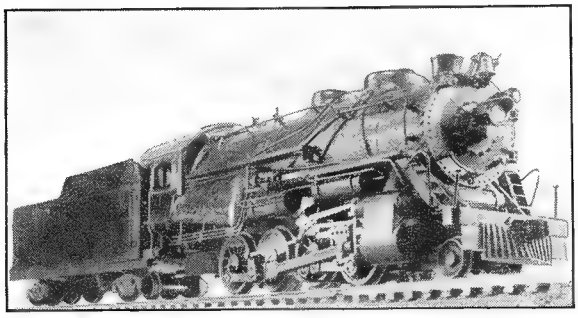




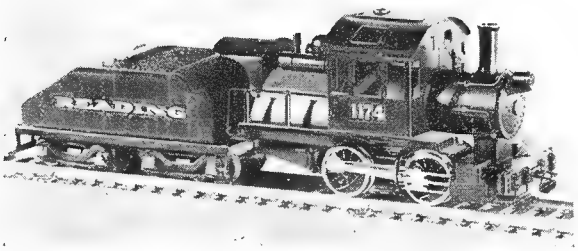
The Varney Yellowstone above is the largest of HO locomotives.



Varney Mikado.



Varney Consolidation for freight service.

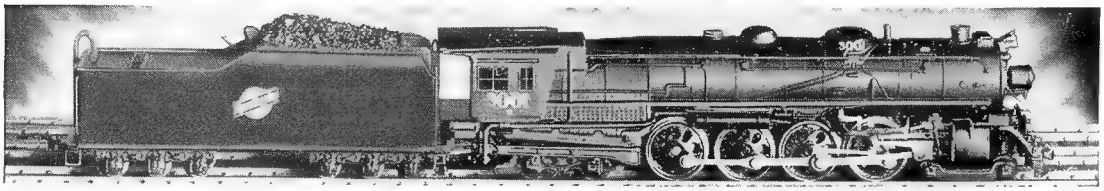


Mantua's famous 0-4-0 "Mother Hubbard."

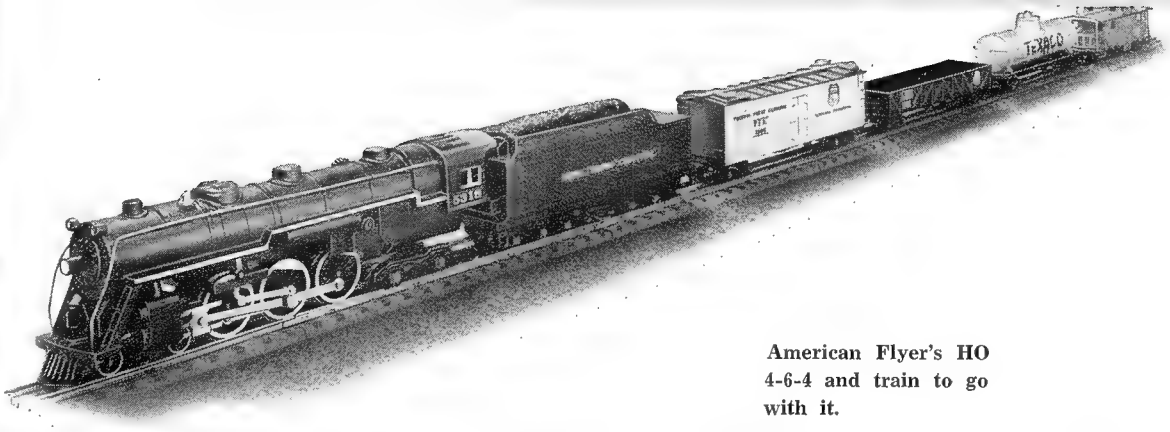
and transfers, for the finished job. Each kit has usually a complete set of drawings and instruction sheets which describe precisely how to assemble the parts. Most firms reduce the soldering work to a minimum. A file or two, a hand drill, a soldering iron, pliers and a screw driver are about all the tools required to complete the average kit. Sometimes there are extra items which require to be specified in the order, such as whether the outfit is to be two- or three-rail, whether an automatic reverse and an electric working headlight and so on are desired. And there must be mentioned the distinction between kits and loose engine components. Some manufacturers, while they supply complete sections of kits, do not supply loose accessories for their locomotives. Yet there is also a splendid range of independent locomotive components to be had.

O Gauge Kits.

In O gauge the firms providing engine kits include Walthers, the American Model Railroad Co., Scale-Models Inc., Lobaugh, the Congress Tool and Die Co. (Min-I-Scale), Lionel, and Thomas Bedell. Min-I-Scale models are built to $^{17}/_{64}$″ scale. Certain other firms like Parmele and Sturges not only retail their own products, which include New Haven O gauge electric locos, but act as agents for most other firms. Thus, a list from one of these houses will serve as a good handbook to the products of the lot. There are a large number of these retailing stores throughout the country and to enumerate them all would be next to impossible; the best

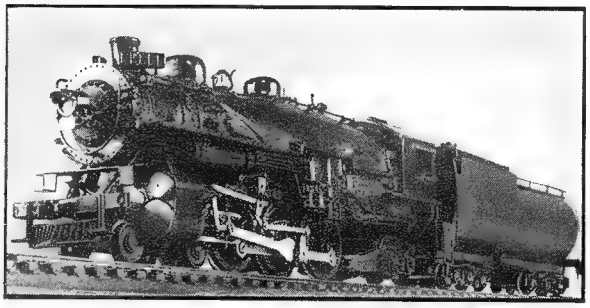


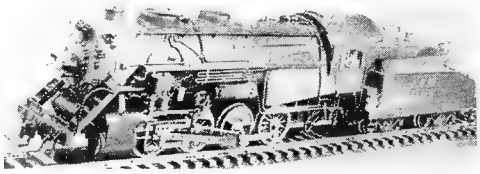
Scale-Models C&NW Class H Mountain loco in OO gauge.

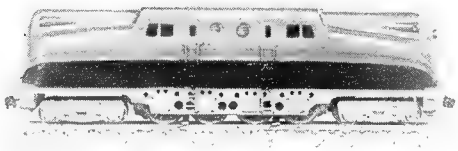


American Flyer's HO 4-6-4 and train to go with it.

course to follow is to study the advertisements in the railroad modeling magazines. It would also be impossible to describe in detail the various individual power units provided, though a number may be briefly indicated. Lobaugh's leading models in this scale are an SP Mikado and an SP switcher, both of very handsome design and workmanship. Scale-Models Inc. also provide several, the most outstanding of which is a Southern Pacific Mountain type. Some of the offerings of this firm are illustrated, the already mentioned engine, a close-up of the valve gear on a Hudson and a view of a Pacific mechanism or chassis complete. These are all kit-built features. An interesting group is also given of the complete set of six kit-sections which cover the construction of the Mountain engine by this company. Some idea of the kind of details supplied will at once be gathered. Hudsons have probably been a little overdone in this standard—there are two others by Min-I-Scale and Lionel, both excellent work. Lobaugh provides two types of six-wheel switchers, a Mountain and a Mikado. This firm has a fine reputation and guarantee first-class production. One of the very finest and most detailed kit sets on the market is for a Pennsylvania K-4 Pacific by American Model Railroad Co.



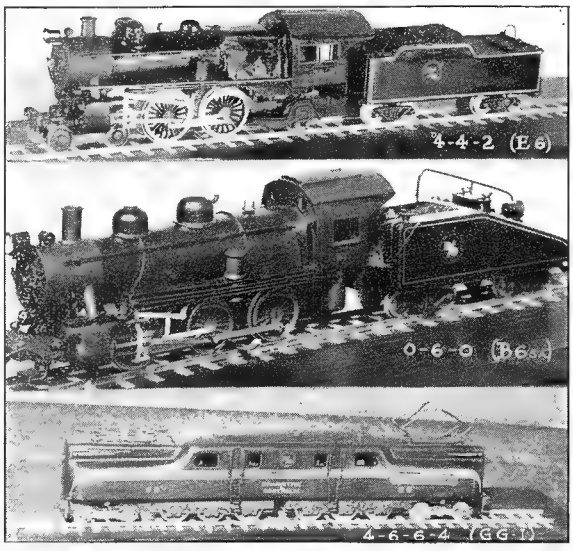




Above: Pacific. Below: Switcher and Electric. (Varney.)

Thus far we have had no opportunity of writing in detail of the ⅞″ gauge material.

⅞″ Gauge Kits. That was because the models are supplied only by the Cleveland Model and Supply Co., and are only sent out in kit form. The construction drawings are given to full size and the locomotives are carefully detailed. Plywood is used for some of the smaller detail work which might be more acceptable if provided in die cast metal. Molded wood is also used



Right: G. D. Stock locomotives for HO gauge.

for the boiler and smoke box and for some of the circular fittings, but the work is well wrought. The cab is cut from thin plywood on which the outline drawing is printed. The main tender block is also of wood, and this applies to tenders of certain other firms. Truck frames, running gear, side rods are all of course in metal and well executed. Very good insulated wheels, centers, tires and counterweights separately are furnished. The advantage of this form of construction is its cheapness; the models are sold at a price which is far below the standard all-metal product.

OO Gauge Kits.

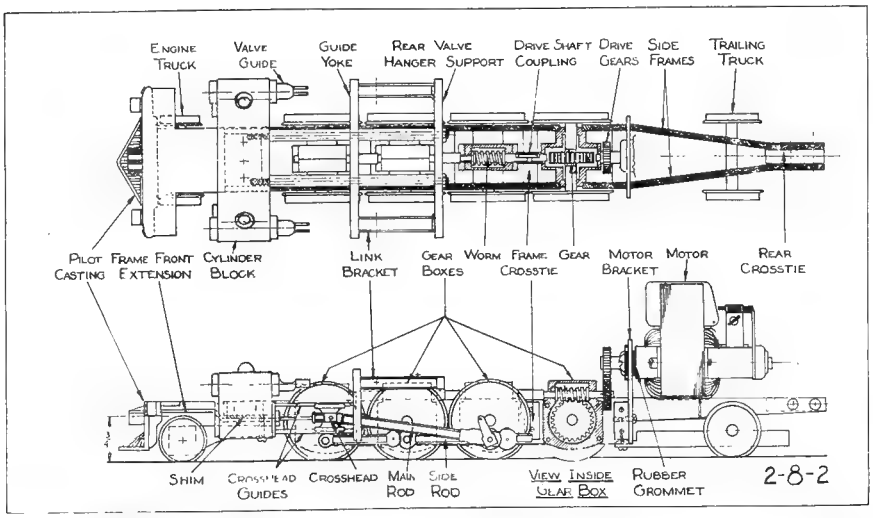
In OO gauge several units have been already mentioned as sold in their finished form. Kits may be had for all these unless they are mass produced. A notable example is that of the Nason Hudson, a piece of very precise engineering. Its companion is a very handsome Consolidation.

Kits for HO Gauge.

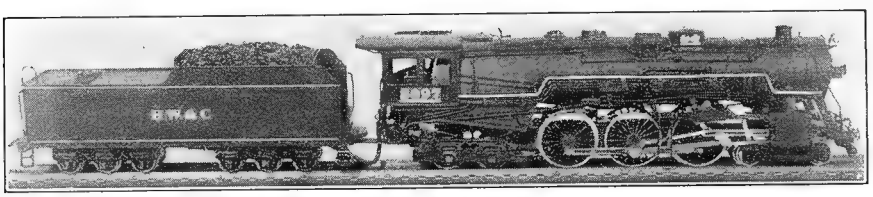
For HO gauge, all the scale engines described, by Varney, Mantua and the Model Railroad Shop are obtainable in kit form as well as completed. Varney also has two very handsome freight engines, a Consolidation and a Mikado. The latter is the most detailed model yet produced in this scale. Walthers offers a fine HO gauge Hudson, a Milwaukee Road model. In this unit provision has been made for dropping of the drivers out of the frames when desired. Drivers are drop forgings having a dull nickel finish. The tapered boiler is turned from brass tubing and comes assembled to the fire box, cab roof and running boards, the cab roof being a single casting which includes the turret and front of cab. Other important details are all in finished casting form. If so desired this engine can be had in completed form, the price being very reasonable.

Varney locomotive kits are exceptionally well done, and comprise some of the finest die casting and machining work the writer has seen. The springing of the drivers is a most advantageous and original feature in this size; it was found by the writer on experiment that it was utterly impossible to derail the Pacific chassis on any part of his extensive layout. Its running was faultless and its slow-speeding unequaled.

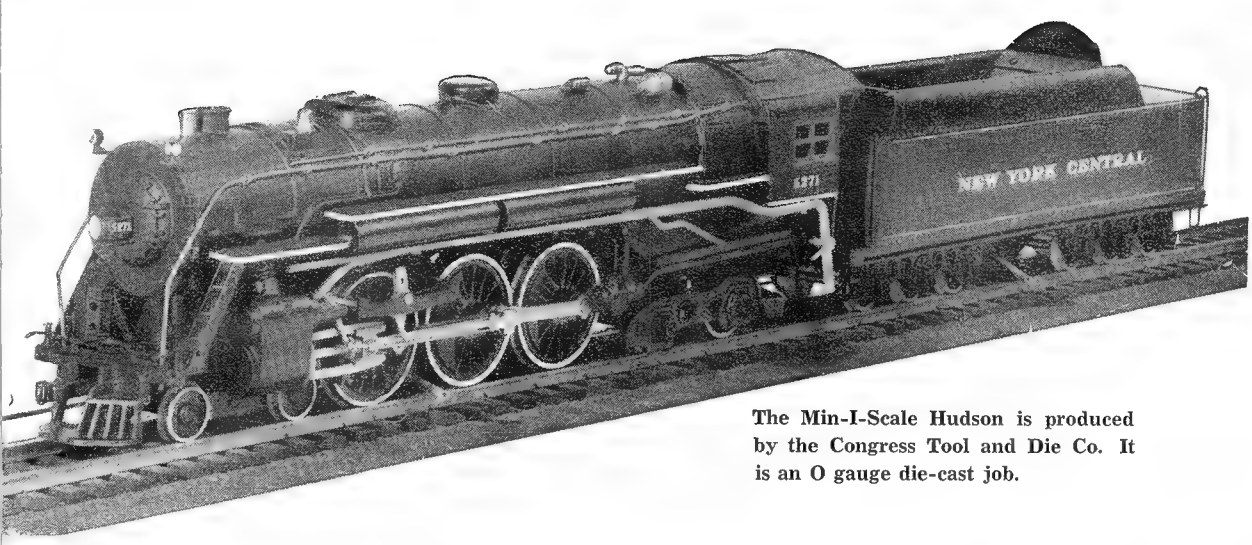
The only possible objection the writer has found in the whole kit idea is a certain tendency to fight shy of the use of a soldering iron. This seems to be a pity. There is nothing whatsoever difficult about soldering of



Recent development in locomotive drives is this Polydrive unit by Walthers. Any number of axles can be driven by this method.



W. K. Walthers HO gauge Baltic type locomotive.

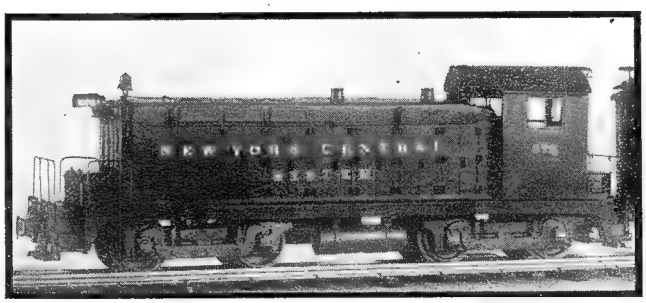


The Min-I-Scale Hudson is produced by the Congress Tool and Die Co. It is an O gauge die-cast job.

the most intricate or artistic kind when once the simplest lessons have been learned by experimentation. And there is no satisfactory way of building a locomotive model that does not demand a great amount of soldering work. More may be said upon this matter in the proper place; but the buyer of engine kits is urged not to be guided wholly in his selection from the standpoint of the elimination of soldering. Too much reliance can be had upon unsatisfactory cements.

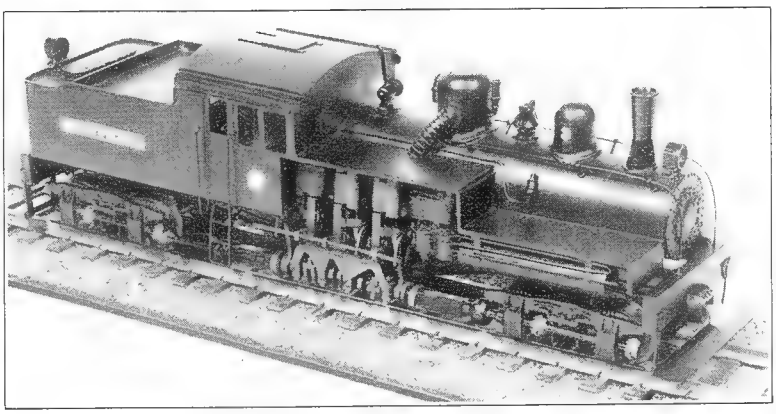
Building Without Kits.

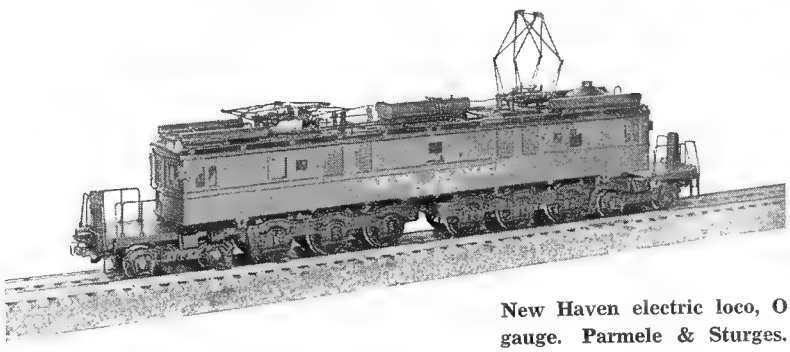
But the time will probably come when the builder himself will want something different in the way of cost than the ever blessed locomotive kit. He will want to do free lance construction after his own design and ideas, and for this work there are no kits provided. Building without kits is an art which must have a chapter for itself; but before concluding the present one it may be well to discuss an item, and a fairly comprehensive one, which goes along with this "kit-less"



O gauge Electro-Motive switcher by Hawk Models of Chicago.

Below: Shay locomotive (O gauge) built by W. K. Walthers for use at N. Y. Fair.





New Haven electric loco, O gauge. Parmele & Sturges.

effort, namely, the supply of components. As already indicated, it does not follow that firms supplying kits also provide individual parts; but many of them do. It may be a matter of urgent interest, therefore, for the amateur to know just what can be had.

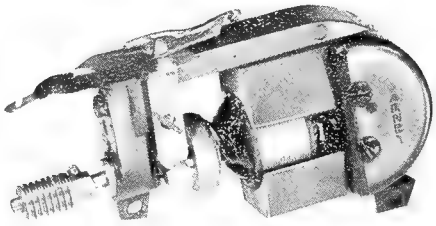
Motors and Mechanisms.

First, as to motors and mechanisms. The Kendrick & Davis series wound 12 volt D. C., 16 volt A. C., motor is practically standard in O gauge. This motor has oil-less, self-alining bearings and is made in four sizes, the smallest being known as the No. 1 and the largest as No. 4. The No. 2 and No. 3 sizes are used for average locomotives, the No. 1 for motor cars which will not haul more than a trailer or two, and the No. 4 for super power locomotives intended to pull 40, 50 or more cars. This type of motor is reversible by a hand operated switch or by various remote control systems. The more popular schemes are the Walthers relay, which uses A. C. to run the motor and D. C. to reverse it, and the Nieter rectifier scheme, very simple and with no moving parts, which uses D. C. for running the motor and reverses simply by reversing the direction of the current.

The Model Railroad Exchange makes permanent magnet fields which can be used to replace the wound fields in standard O gauge K&D motors, giving them the same ease of reverse as the HO gauge permag motors. These magnets have been found about equal in efficiency to the series motors. The same firm also makes a line of small series wound motors used for OO gauge and for O gauge motor trucks, old timers, and switch engines where space is very restricted. Nason also makes a good OO gauge series wound motor.

HO Permag Motors.

For HO gauge the Varney, Knapp, Mantua, and Pittman motors are so excellent that they are extensively used as standard by various firms. All Varney motor parts are designed for interchangeability, and separate parts can always be had, whether magnet, frame, screws, bearing brackets, brush supports, brushes, brush springs, bearings, washers or armature. Proper oiling-

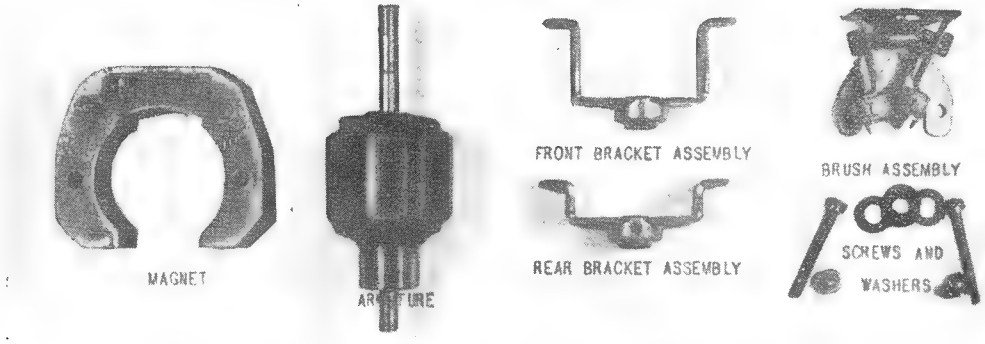


Superb HO motor distributed by Varney dealers. It will operate smoothly at the lower speeds as well as at full running speed.

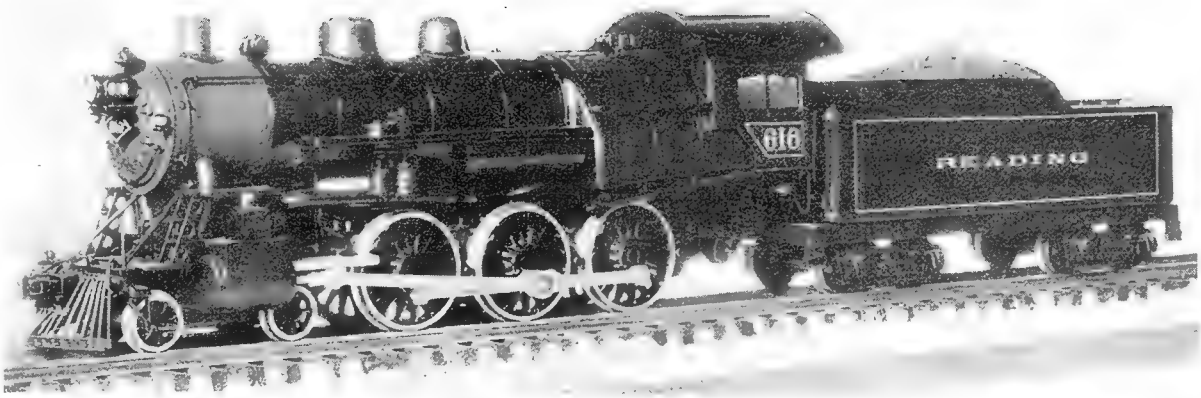
access holes are provided. Brushes are entirely self-lubricating.

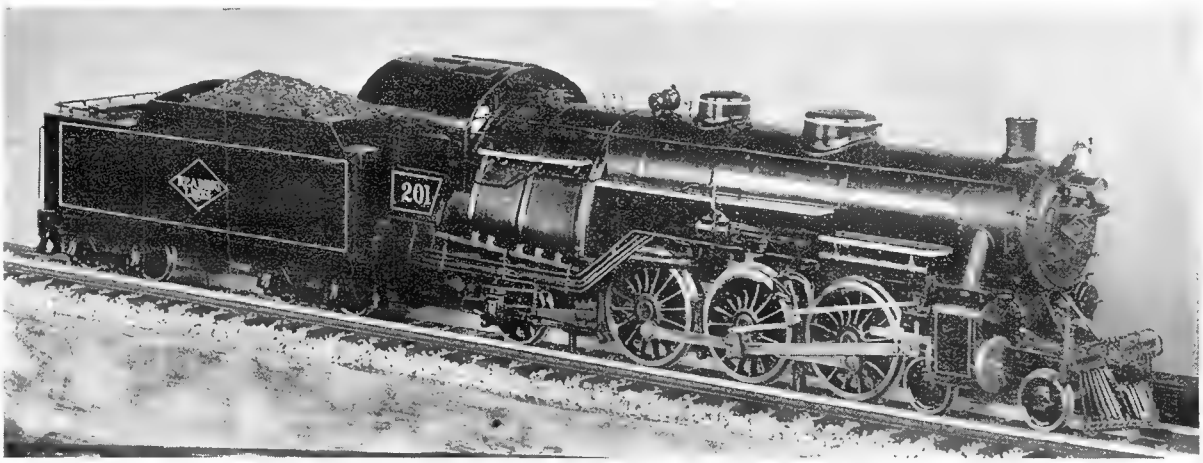
Two-Rail and Three-Rail.

Before leaving the subject of mechanisms and motive power it may be well to dwell briefly upon the subject of two-rail and three-rail current supply insofar as this affects commercial products. There is not much doubt that before very long the two-rail system will be the only system in general use for steam type models as well as outdoor layouts. Right from the start, the unrealistic and entirely monstrous third-rail for steam type engines has been a bane to any fastidious worker. Locomotives and cars can be fitted for two-rail operation without serious difficulty; every kind of



Permanent magnet assembly to convert a Kendrick & Davis O gauge motor to a D. C. motor reversible by changing the current polarity. Made by Model Railroad Exchange.





American Model RR. Co. supplies a great variety of O gauge locomotives. Above, a Reading Ten-Wheeler. Below, a Pacific from the same railroad.

switch and crossing has been found adaptable to its use. The unsightly "cow fence" and projecting third-rail shoes are alike doomed. It is a perfectly fascinating thing to watch the tiny hogs move along as they ought to do on two rails, like their real brothers. And aside from the factor of appearance, the advantages of the system are many. There is no longer any failure of current due to the fact that collectors are not contacting at switches, where "jump-overs" frequently occur with conductor rail. Switch construction is greatly simplified, unless it be on double and single slips, and even they are quite readily connected up. Several of the firms who produce two-rail locomotives provide for the collecting of power by way of a tiny shoe bearing on one of the rails, but the better plan is to have the engine wheels insulated to pick up the positive and the tender wheels the negative, thereby abandoning all outside forms of current collecting. The insulation work on the majority of HO gauge engines is very ingeniously accomplished so that there is no wear whatever on the insulation, all tractive wear occuring only on steel or brass tires.

Insulation of Mobile Equipment.

On the subject of insulation as applying to locomotives and rolling stock the following notes by W. K. Walthers are so excellent and concise that it might be well to quote them in full. Writing in the Crestline News, the house journal of his firm, he says:

"In a three-rail system both running rails carry the same polarity, hence the wheels and axles may be constructed solidly and there is no need for insulating the wheels on one side from the wheels on the other. In a two-rail system it is necessary to carry one polarity in one rail and the opposite polarity

in the other. This calls for an insulating medium somewhere between the wheels. It also calls for the use of non-metallic ties so the rails are not electrically joined. Switches and crossings must be insulated where one rail crosses the other. Some types of track patterns require special handling to prevent short circuits between rails. There are other requirements, and these will be discussed in turn.

"On cars where it is not necessary to pick up power, a wheel made of insulating material such as bakelite should work well. Bakelite wheels have been tried but so far this material has given trouble because of its brittle quality. It not only chips at the flanges when striking against frog guard rails, but frequently cracks when pressed on the axle. Steel and brass wheels can be used by putting an insulating bushing of fiber or bakelite between the axle and the wheel. This is far more satisfactory than bakelite wheels. Usually only one side of the axle is insulated. However, if the car has a metal underframe, it is necessary to insulate either both wheels or the connection between the truck bolster and the underframe. Otherwise current will flow from the uninsulated wheels through the truck to the underframe and thence to the next car by way of the couplers, and also to the other truck on its own car. This would set up a dead short circuit between rails.

"In the case of power driven cars (or cars with electric lights) it is essential that the wheels on one side of each truck be left uninsulated so the wheels may serve as a power pickup. If the wheels were insulated on both sides of every axle, it would then be necessary to provide shoes to ride the track in order that power might be conducted from the rails to the motor or lights. However, and this is important, the trucks must be so placed that the insulated wheels of one truck ride on one rail and the insulated wheels of the other truck ride on the other rail. If the car has a metal underframe, the bolsters of the trucks must be insulated from the underframe. Then if you attach one wire from the motor to one truck bolster, and ground the motor to the other truck bolster, current will flow from one rail by way of the uninsulated wheels and frame of one truck through the motor and to the other rail over the frame and wheels of the other truck. If by chance you place your trucks so the insulated wheels of both ride the same rail, nothing will happen as both sides of the motor will be connected to the same rail. Turn one truck around and the circuit will be complete between the two rails. In any event there will be no short circuit. If you do find a short circuit, look for trouble where the truck bolsters come in contact with the underframe or where the wheels are insulated at the axle.

"In the case of steam type locomotive it is necessary to insulate all the drivers on one side. This insulation is done either at the rim or by bushing both the axle and the crank pin holes. The uninsulated wheels on the other side then serve to pick up power from one rail. The wheels of the pilot and trailing trucks must be insulated on one side and from the frame by insulating the contact between bolster and frame, or on both sides. The wheels of the tender are insulated on one side and from the underframe. The tender trucks are used to pick up current from the other rail, so the trucks must be placed with their uninsulated wheels on the same rail on which the insulated wheels of the locomotive ride. A wire attached to the frames of these trucks is carried forward to the motor. The method of insulating and placing trucks may seem a little complicated to a beginner, but is easy to figure out if you follow the path of the current from one rail to the motor and back to the other rail.

"Cars designed for the two-rail system can be operated on three-rail track without change, but three-rail equipment will not operate on two-rail track. Therefore, if you are contemplating a change to two-rail later on, let us recommend that you start buying two-rail equipment from now on and run this on your three-rail track until you change over."

Components to Be Obtained.

So far as the actual provision of parts is concerned, no difficulty will be experienced by the builder. Parmele & Sturges, for instance, keep a most exhaustive supply of every kind of accessory for O gauge and HO, as well as OO. Every sort of minute detail is handled,

including ball bearings, bells, domes, sand boxes, feedwater heaters, injectors, trucks, valve gear parts, steps, wheels, water scoops. For O gauge the same applies to Lobaugh and Walthers, and for HO to Varney and Walthers. Lange's Model Supplies of Chicago also specializes in this department, as does George Stock, Philadelphia, for HO gauge.

Locomotive Trucks.

The matter of locomotive tender trucks is an important one and a few additional remarks might be made concerning this item. Of all varieties in regular use on actual railroads there is a corresponding supply, broadly speaking, for model work; but up to the present moment there are one or two gaps in the requisite series. This is not so apparent in the O gauge supply; almost every type can be had, whether Commonwealth, Andrews, roller bearing or those for the 12-wheel Hudson tenders. This also applies to leading and trailing trucks for engines. In many instances the side frames may be had separately, so that the trucks themselves may be built up by the amateur. The very best trucks for locomotives and cars alike are manufactured by Carl C. Auel of Irwin, Pa., these being literally marvels of perfect detail, a complete replica of the actual thing down to the minutest item. Several of these can be had for replacement. Six-wheel tender trucks, however, appear to be absent from this fine series. In OO gauge the need is plentifully met by Scale-Models Inc. and by Nason Railways, these firms supplying various types including Hudson tender trucks, Commonwealth and roller bearing types. The ⅞″ gauge range is limited to the two or three types of engine provided, but the metal diecastings for the sides are well executed. Lead and trailing trucks may usually be had from the manufacturers for the particular type of engines they retail in kit or model form. A very complete range for HO gauge is kept by George Stock and by Lange's Model Supplies. These include leading trucks, six-wheel Commonwealth, and those as used on the Varney tenders. All of these various types can be had suitable for either two- or three-rail power supply. The best course to be followed is for the reader to consult the advertisements in The Model Railroader and to send for the lists of all the firms providing locomotive parts.

Suggested Refinement.

In concluding this chapter, the writer would suggest to the firms manufacturing scale model equipment that it would be an excellent thing if one of them would bring on to the market a small automatic electric whistle for universal application to engines of any standard gauge that would do the work accomplished by the Lionel whistle on their O gauge models. This would surely not be a very difficult task, and it would certainly meet with general popularity among all scale fans if the price were reasonable. It should be designed for remote control, for operation from the switchboard by means of rubbing contacts at certain points of the line, and it should be so designed as to fit into any standard HO gauge tender. Its note or tone should be exactly correct.

Wheel Clearance Standards.

The table on page 8 gives the standards for track and wheels adopted by the N. M. R.A. The builder is urged to adhere strictly to these standards in all his work, if only for his own sake, for it will be found that unless he does so his stock will not run on the tracks of a neighboring layout, and he will find it difficult to dispose of his models when he may wish to do so.

3

Electric Locomotives and Multiple Unit Cars.

SEVERAL companies now use electric type engines for both passenger and freight hauling on main lines. The Pennsylvania operates trains electrically between New York and Washington, D. C., the NYC and the New Haven roads use this form of motive power on part of their systems out of New York; the Milwaukee Road has well over 600 miles of electrified main line in the mountains, and the Illinois Central follows the same practice south of Chicago. On the Pennsylvania and other systems there are streamline electric locomotives in operation; this road has no fewer than 80 such locos, including its well known GG-1 type. Freight is hauled over the same route by heavy 4-6-4 electrics as well as by the GG-1's. Many switching yards are powered electrically, and the multiple unit system is in operation over a good mileage of the Pennsylvania, as well as other lines. Interurban railways, linking up adjacent towns and cities, have electric cars of distinctive design and are also deserving of consideration by the modeler.

Interurban Railways.

The interurban railway, as already hinted, makes a most useful and attractive additional feature to an existing model layout. For one thing, it is a side line that can often be added with only single track and will fit into a very narrow spare right of way alongside a main line, or branching off it. On such a subsidiary, stiffer grades are possible, for trains need not be lengthy, and may even consist only of a single car. It therefore becomes possible to carry the tracks readily over main lines by way of flying junctions. Cars can take much sharper curves, their bodies often being short enough to prevent undue overhang. No coaling or watering facilities are demanded, and this means much less outlay in the matter of space. By adopting this system it is possible, say, on a two-rail layout to introduce a fascinating addition of an overhead catenary system; all that is necessary is for the track pickup for one element of the current to be eliminated from the vehicles and connected to the overhead pantograph. That is to say, on a two-rail unit, no wire will be carried from the side of the running gear which gathers the positive, but the wire from the insulated brush on the motor will be connected overhead. Much the same applies to the three-rail system, there being in this case no wire from the outer rail to the motor. Furthermore, the trains themselves offer something fresh in the way of design.

Multiple Unit.

The beginner may not be entirely clear as to the meaning of the term "multiple unit." It does not necessarily follow, with this system of propulsion, that there is a separate motor in every car making up a train. This may indeed be so, and often is; but in many instances the number and arrangement of the motored units is determined by convenience and weight of load. There may thus be trailer cars as well as energized cars if more than one unit forms a train. There may be overhead pickup on all the cars or only one or several of them. The great point about the system in real practice is that the trains may, no matter how lengthy, be driven from either end without turning the cars around. The arrangement of the mechanism in model multiple unit cars varies with the different firms. Some supply a large and very powerful motor occupying a fixed position inside the car (involving opaque win-

HO gauge overhead distribution on the layout of Frank Schlegel, Yonkers, N. Y.

dows) with a gear box working on to the truck axles. Others provide what is known as a motor unit which is made to swivel with the pivot of the truck itself, the second car truck being simply plain.

Catenary System.

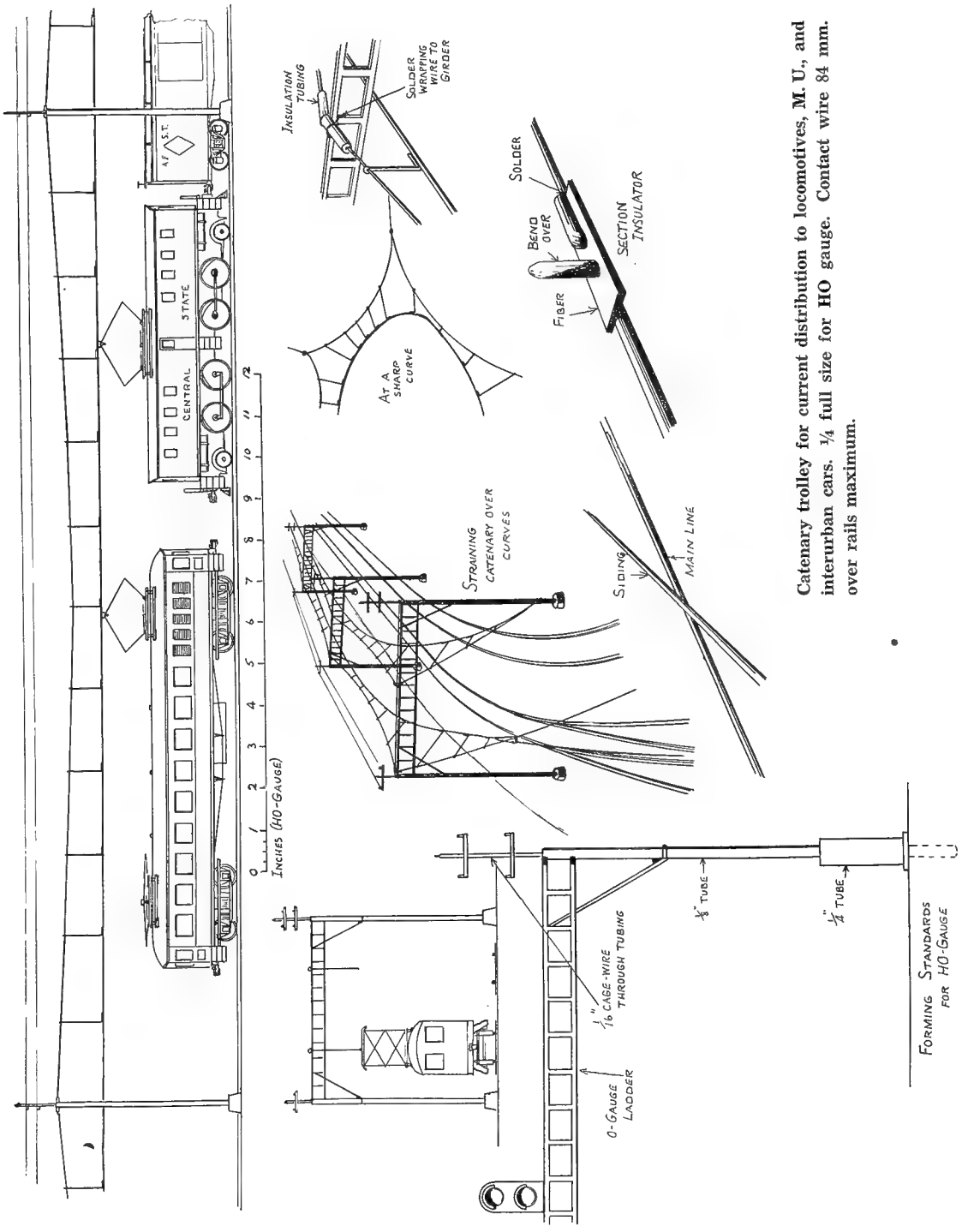
It will be necessary to offer some remarks at this point concerning the overhead system of current supply as it applies to rolling stock. On page 26 we have a number of drawings which afford some guidance. The suggested distancing of the standards is shown in the top drawing, and there is an end section for the scheme just below. Catenary suspension is so termed because of the curve assumed by the messenger wire which supports the lower contact wire. The drawing shows the placing and spacing of the hangers from the messenger to the contact. These are looped in place at the top and soldered at the bottom. The best messenger wire to use is braided radio aerial wire, and picture hanging wire is also good. For the contact wire (O gauge) No. 18 or No. 16 copper wire is suggested.

The lower left hand diagram suggests a scheme for building up the supporting structures in HO gauge. For the cross members punched metal ladder material, as provided for a larger gauge, may represent the lattice. Uprights are of brass tubing, a length of bird cage wire passing through the center, into the baseboard and projecting from the top to form the telephone carrier. On sharp curves the catenary should be furnished with pull-offs. These are shown in two of the sketches, and it is necessary to strain the messenger as indicated so as to secure the requisite curve on the contact wire. The messenger wire must also be insulated from the lattice supports, and this can be done by using spaghetti insulating pipe as sold for radio. The insulated point is wired on to the support, the lattice serving well to give the positions from which to strain the messenger. The number of upright supports for the contact wire should be counted before attaching the messenger, and the correct number of insulating fibers slipped on.

The method of crossing contact wires and

of forming insulated sections in the supply is also shown. The latter is accomplished by use of a small block of fiber with drilled holes through which the contact wire is slotted and soldered. At switches, the switch contact wire is passed over the main, and the hangers must be so arranged that when the collector lifts the wire under which it is running the other contact wire will lift simultaneously.

For street trolley systems a single type of contact wire can be used, and in this instance the collector takes the form of a single pole trolley instead of a pantograph. For this purpose a length of cycle spoke is used. About 3/16" from the nipple a hole is drilled to take a common pin which fastens the nipple to



Catenary trolley for current distribution to locomotives, M. U., and interurban cars. 1/4 full size for HO gauge. Contact wire 84 mm. over rails maximum.

the base. The nipple has two flat faces for a short distance from each end, and the hole is drilled through these. Then the nipple is screwed on the spoke to a distance of 1/16" from the pin, the nipple being then tightened by hammering, so that it will not turn. The spoke is bent at its desired length and a brass pulley slipped on. These pulleys can be had for signaling work. The end of the spoke is then cut off allowing enough to bend over and hold the pulley correctly. The base is formed of scrap brass. Two ears are bent up to take the end of the nipple, which is fixed by means of the pin. A hole is drilled in the base for the spring, which is hooked around the arm above the nipple. The base is then swiveled to the roof by means of a small bolt, so that the trolley is free to revolve in a horizontal plane.

Street Trolley Overhead.

The trolley wire may be supported on its arms by small clips of soft copper 1" long and 1/4" wide, which are bent double over the wire and pinched tight. Then the two ends are bent at right angles to form a T. This may be soldered to the arms or punched to take guy wires. The pulley groove must be so deep as to ride over these clips without jumping.

For the construction of interurban cars the amateur will find that numerous parts are available. The advantage of this type of power is that it does not incorporate the detail usually found on steam outline locomotives. Multiple unit cars are built on much the same order as a standard coach except for the fitting of the motor and the pantographs, third-rail shoes or trolleys. For the amateur, unquestionably the simpler course is to fit one of the motor units available to a standard passenger car and then add the accessories. There are a number of motor mechanisms to choose from, some manufacturers offering several types. There is also a complete O gauge chassis to suit a main line electric locomotive sold by T. G. Bedell, and known as the B-Lectric mechanism. Although this is designed to 17/64" scale, it is very popular with the 1/4" scale adherents. This chassis can also be had as part of a kit. For OO gauge there is an entirely new swiveling car mechanism by Nason Railways, and for O or HO there is a most compact and useful example of the same kind by Walthers. Bedell makes one for 17/64" scale, O gauge (Fig. 16). Given suitable gearing, of course, any standard O gauge locomotive motor will serve as power for an electric engine having a fixed wheelbase or rigid chassis, and the more powerful it is the better.

Electric Outline Engines and Interurbans.

There are also numerous ready-built electric locomotive units on the commercial market. Many of these are shown in the photographs. The O gauge streamline model offered by American Model Railroad Co. has a body which has a one-piece superstructure casting in bronze representing the famous GG-1 class type. It is nearly 20" in length and will negotiate curves of 3 ft. radius. It is also supplied in kit form with either a single motor or a dual mechanism. The Walthers O gauge electric switching model is built after the Ingersoll-Rand oil-electric design, is only 9½" long, and will take 2 ft. curves. Kits are supplied in four sections. The Pennsy multiple unit coach by the same firm is a familiar model, while other MU cars of different design but on similar principles are produced by the same shops. The Nason Company produces OO gauge kits for a very good 4-6-4 electric main line engine and these may be had either finished or machined. Two Nason super-motors are installed, and the pantograph can be wired for actual current collection. An excellent O gauge electric of the New Haven type is manufactured by Parmele & Sturges of New Haven, and it may be purchased finished or in kit form. Two other examples may be mentioned, the Walthers gas-electric car for branch line use in HO and the main line 4-6-4 electric engine in the same gauge by Varney. Both may be had as kits or finished units. Yet another New Haven model in O gauge is that of a switcher by American Model Railroad Co.

Commercial Models.

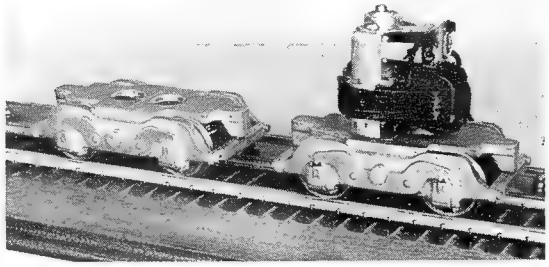
The English-made Reidmere standard engine, motor of the four-coupled type, with small solid car wheels fitted, can be used for HO MU car drive. The drawing on page 29 gives suggestions for fitting the motor to the body of a car, the work being very straightforward. All that is necessary is the

addition of an overhead bearing beam of brass strip which can be soldered to the body of the mechanism, and which is pivoted under the roof of the car. A car fitted with this motor will easily haul an entire train of six or seven cars. It is recommended that the small 16.5 mm. wheels be forced on to the axles and afterwards soldered on the bosses, and that side rods be fitted.

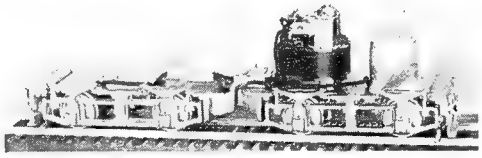
Home-Built MU Car.

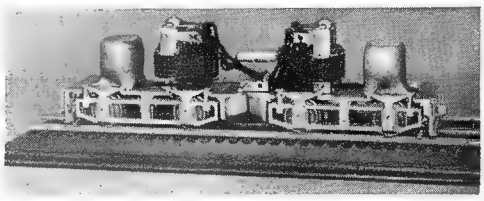
Modeling streamliners in the home workshop is not the simple matter it would seem to be. Up to the present there has been evolved no simpler method of forming the gracefully shaped body work for the car ends than that of casting in metal and machining. Some light variety of wood, such as balsa, might be substituted at some sacrafice in strength and detail.

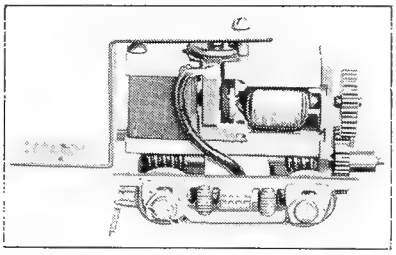
Modeling Streamliners.



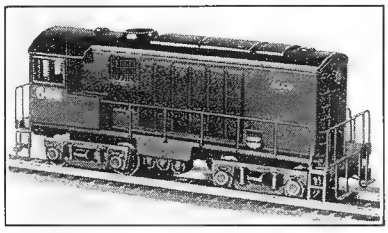
B-Lectric (Bedell) M. U. trucks and (below) single and double motor locomotive chassis. Note weights to increase traction.



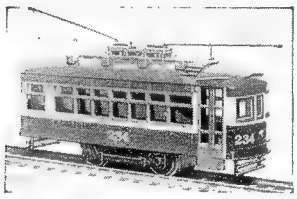




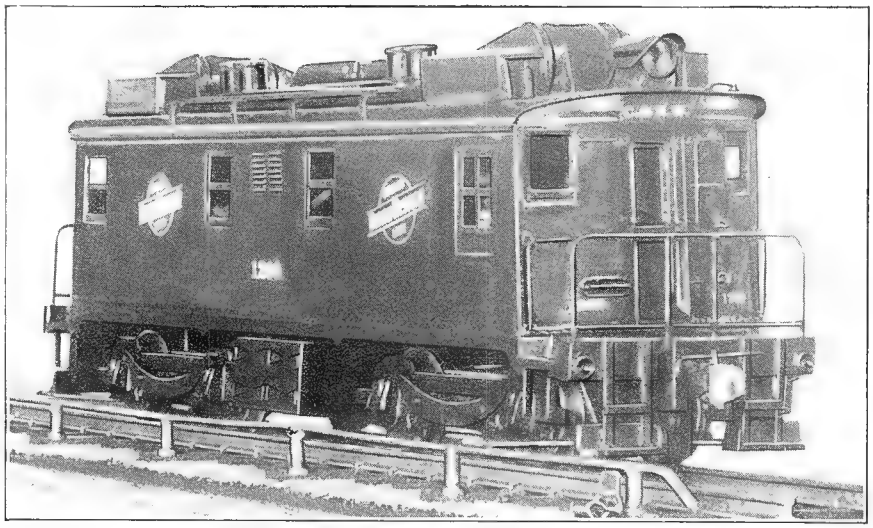
HO gauge M. U. truck provides a good beginning for free lance models as well as scale jobs. W. K. Walthers Inc.



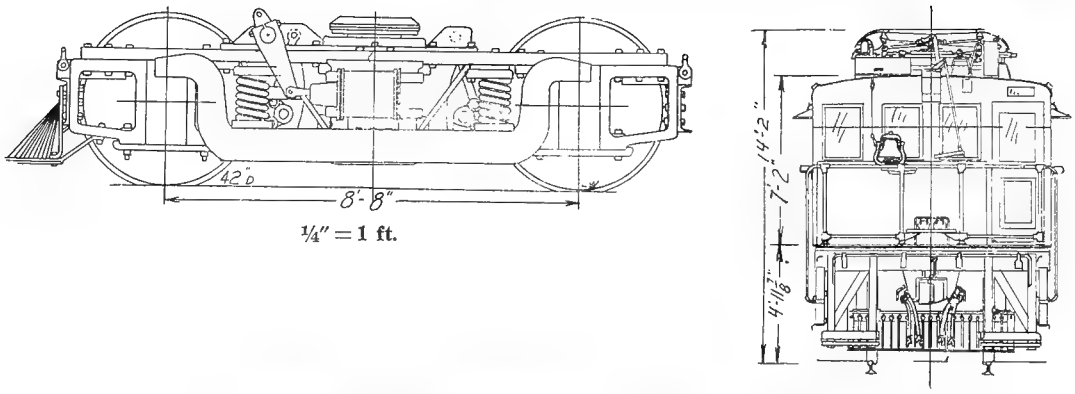
HO Alco switcher by W. K. Walthers.



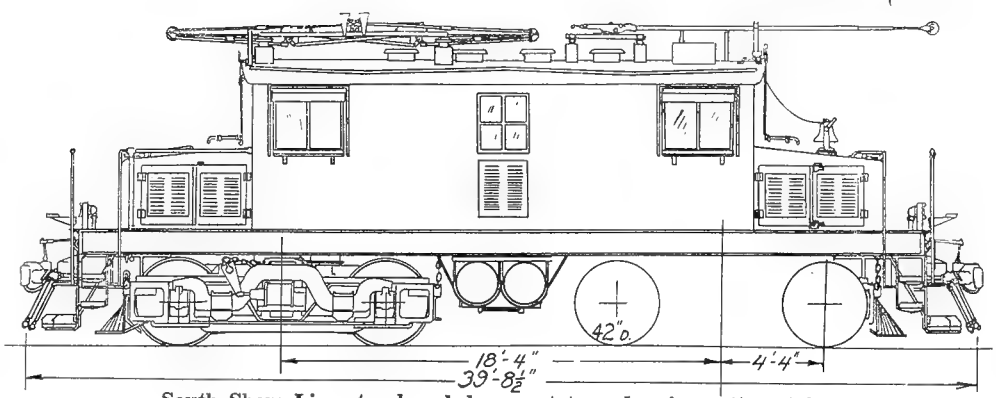
Walthers Birney safety car.



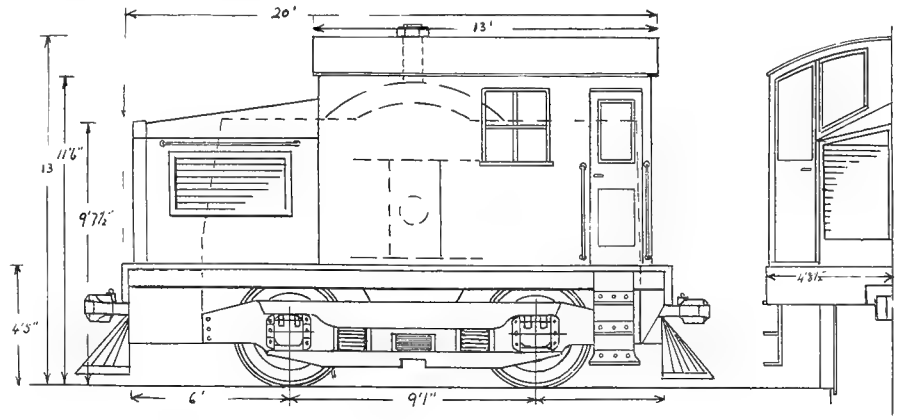
O gauge switcher is a handy locomotive. This is also made by W. K. Walthers.



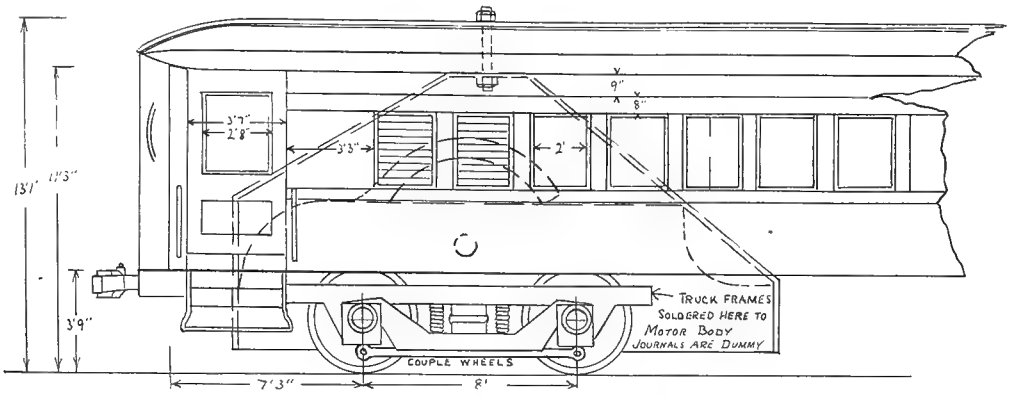
¼" = 1 ft.



South Shore Line steeple cab loco prototype drawings. ⅛" = 1 ft.



Switcher (above) and M. U. car (below) which can be made from parts.



4

Building Motive Power.

THERE are several thousand distinct designs of locomotive in service on the larger railroads of this country at the present time, to say nothing of the designs that have become obsolete in past years. Almost every one of these styles has a model follower somewhere. We all like those engines with which we are most familiar; but no matter what we want to build we must remember that it is impossible for the manufacturers to stock parts for more than a small proportion of these designs. A few of these locomotives can be built by using parts and castings listed by the modeling firms, but for the big majority of designers even this may not be possible. The only course seems to be that of setting about to make almost all the fittings and the entire superstructure oneself.

The first necessity is that of scale drawings. No scale model can be built without them.

Scaling Down Drawings.

There are many sources of locomotive plans. The Model Railroader prints many. The Locomotive Cyclopedia, various editions of which are probably in your public library, has many designs. Technical magazines such as the Railway Age and the Railway Mechanical Engineer illustrate designs of new engines, copies of which can be seen in the public libraries. But drawings are not enough. To do a thorough job one should obtain photographs if possible. The Model Railroader Cyclopedia combines prototype drawings and photographs. If a particular railroad runs through your town so much the better. First hand observation is a great help.

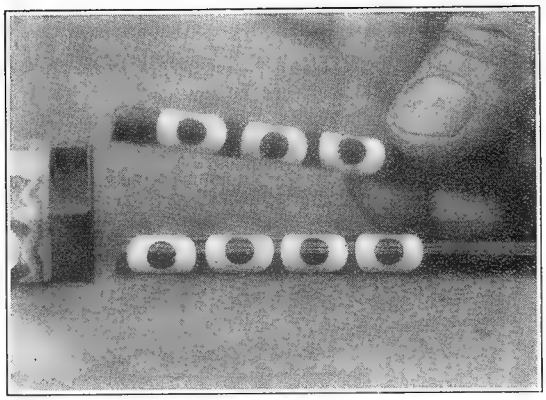
Yet after all is said and done, the personal qualifications needed in building up a thorough model of this type are (a) perseverance, (b) knowledge of the subject, (c) tool skill and (d) some measure of skill in draftsmanship. A really good scale rule, one of simple form, should be secured. These are calibrated in scale feet and inches and no conversion process is required. Rules scaled for the 17/64″ scale can be had from Carl Auel, for 3.5 mm. scale from Varney or George Stock, for ¼″ scale from any good art dealer. It is an important thing to bear in mind that no two locomotives, even of the same class, are ever exactly alike, and it is therefore necessary to obtain detailed information of the particular loco you are intending to build. Many designs in this book are given to a scale of ⅛″. For ¼″ scale they should of course be doubled. For HO gauge 10% is added to all dimensions. Parts that are not shown detailed in the diagrams should be assumed to take the usual form. Thus, if no details of trucks are given for a passenger car, use Pullman trucks. If drivers are not detailed this implies that they are spoked.

One excellent method of obtaining exact drawings is that of having the drawing photostated to full size for your scale. Thus, for example, the drawing of a 40 ft. box car may be made to measure 10″ from end to end, which makes it easy to copy because all parts shown are full size for your O gauge model.

It is not at all a bad idea for the enthusiast who feels that he lacks any capacity for draftsmanship to take a course of lessons at a winter night school. It would be far from a waste of time. The writer of this book makes no claim whatever to anything but the poorest of mediocre gifts in this respect but anything he has learned upon the subject in a

professionally crowded life was thus imbibed. His one regret is that the sessions did not cover a long period of years. More decent work might have resulted, and it would have been worth while, even for a hobby.

A few useful tips were given in The Model-maker for 1935 by Frank Bentley, with a view to aiding the draftsman. These included the scheme for marking pencils which the photo indicates. Instead of notching the pencils, simply stick loose leaf rings on them. This will show the grade just as quickly. The use of a reading glass is also an unspeakable boon to the continuous worker. With its aid, small lines, and especially shading on perspective sketches, can be inserted without eye strain. It takes many years to learn the art of tiny lettering, and some of us are far from learning it yet; but this is one of the best possible aids. It would even be well spent time, if a very large glass can be obtained, to build a permanent jig which might be placed over the work leaving the hands free. With the process of experience in drawing work the amateur will quickly devise many other useful and time saving helps. Every model railroader, of course, should possess something really complete in the way of a drawing outfit. If you have no such outfit, all I can advise is that you put it on your next birthday list if you feel you can't afford to invest in one yourself.



Pencils marked for grade.

Before attempting to build a model locomotive something should be known of the

Structural Effects on Haulage.

importance of structure in relation to hauling power. Never be content merely to aim at appearance in a piece of motive power; the running is much more important. Nor is the matter of running more worthy of attention than that of hauling. Many a model the writer has tested could run excellently, but could only haul itself. And this is not a matter merely of the motor, though that indeed counts. The following are the factors which bear directly upon running and haulage: gear ratios, track grades, track evenness, sprung drivers, diameter of drivers, presence or absence of flanges of drivers, adhesive weight of superstructure, and then mechanical considerations such as the free working of moving parts, single or dual drive, magnet power, type of commutator and brushes and the voltage and amperage of the power to be supplied.

Gear Ratios.

First we will deal with the characteristics of the motor. It is often taken for granted that for fast running the gearing should be high and for slow running it should be low. But this is only the most superficial of rules. On the author's layout there are allegedly slow moving power units which, because of the fact that related requirements were overlooked, are almost totally inefficient. And there are highly geared units which though they will run fast have hauling efficiency. The question of gearing is purely relative, especially where an electric motor is used. A multiplicity of spur gearing will defeat itself by reason of itself. That is to say, the gearing itself will swallow up the motive energy. The unit will run slowly, will start and stop with admirable deliberateness, but there may be less power than in a highly geared unit. Nor does the question of size of drivers wholly meet the situation. All things considered, the writer recommends the use of worm drive for all electric models required for slow speeds and power. Moreover, it must be remembered that where the third-rail system is in use, a slowly moving unit will refuse to run with sufficient velocity to clear gaps which may occur in the supply rail at switches and crossings. This is a point in favor of two-rail. Again, you must be certain that all moving parts move with absolute freeness and symmetry; and this applies especially to the side rods. There must be no hint of jerk-

ing or binding or crooked wheels or tight pins. Bearings must be placed with meticulous accuracy.

The power of the magnet in a permag motor is of paramount importance, too. For many years a well known motor on the market was a mystery to its creators. It tended to overheat to such an extent as to be always softening the medium from which the brushes were made, so that after two minutes running it invariably began to lose speed and power. After some careful investigation it was decided to substitute a more powerful magnet, and the result was seen in a doubling of efficiency at once. The brushes themselves should be of oil-less carbon or copper gauze, and they should have some form of adjustable springing, so that during wear they may be tightened up. Brush springs should be truly springy, not a mere heavy and dead pressure. The matter of voltage and consequent amperage is a moot question still. Most of the firms insist that efficiency cannot be given to an O gauge model at less than 12 to 15 volts; many insist upon the need of even 20 volts. But nothing in excess of 12 volts D. C. or 16 volts A. C. is really necessary for any indoor model if the parts are to scale and the motor really efficient, and even a lower figure can give entire efficiency. But when it is insisted that 15 volts are required for sound running in HO gauge the designer has a lot to learn. Six volts are entirely and universally adequate, given the correct conditions, and 8 volts will give excessive speed and power for 6 volt motors. A twenty-car train can be hauled on any permissible grade, not steeper than three per cent, on straight track with an effective 6 volt mechanism. There is thus no real excuse, excepting that cheaper transformers can be built, when the toy manufacturers select a voltage for their outfits which puts the latter outside the realm of scale modeling.

Wheels.

The size of the drivers of a model engine is, of course, important, aside from the fact that the various types of engines have their respective dimensions for drivers. Below we have a chart which sets forth the normal usages of the various diameters of driving wheels. This should be strictly adhered to in accordance with the particular type modeled, and it will be found that such a procedure will modify

Table of Driver Sizes and Applications

Driver size dia.	¼″ scale size ins.	$\frac{1}{64}$″ scale size ins.	HO size mms.	OO size mms.	Types upon which this size is common.
51″	1.06	1.13	14.9	17.0	All switcher types. 2-8-0 Consolidation, on some. 2-6-2 Prairie.
56″	1.17	1.24	16.3	18.7	4-6-0 Ten-Wheeler. 2-10-0 Decapod.
57″	1.19	1.26	16.6	19.0	2-6-0 Mogul. 2-8-0 Consolidation. Mallets and articulateds.
61″	1.27	1.35	17.8	20.3	2-8-0 Consolidation. 2-10-0 Decapod.
63″	1.31	1.39	18.4	21.0	2-8-2 Mikado, almost universal on this type. 2-10-2 Santa Fe. 2-8-4 Berkshire. 2-10-4 Texas. 4-4-0 American.
69″	1.44	1.53	20.1	23.0	4-8-2 Mountain.
73″	1.52	1.62	21.3	24.3	4-6-2 Pacific, very common. 4-6-4 Baltic (Hudson). 4-8-4 (No generally accepted name for this type.)
79″	1.65	1.75	23.0	26.3	4-6-2 Pacific.
80″	1.67	1.77	23.3	26.7	4-6-2 Pacific. 4-4-2 Atlantic.
84″	1.75	1.86	24.5	28.0	4-4-2 Atlantic. Coming into use on many new high speed designs, also 4-4-4.

to a great extent the speed and hauling power of the finished engine, so long as other considerations which bear upon the subject are observed. A far more important item, however, is that of springing the drivers. This, it is true, has not often been done in small-scale modeling. But experiments show that when every wheel, being sprung, is bearing upon the track, whether it is exactly even or not, every wheel is gripping the rail and there is far less power and speed lost through slipping. Actually, the wheels of a locomotive ought to slip very slightly when the motor is running at full speed on the level. But the wheel slip should never be anything more than nominal. Incidentally, there is better haulage on track that is stoutly laid with plenty of ties and well ballasted.

Another factor deserving of attention is the question of the removal of flanges in order to negotiate curves. Modelers are somewhat too closely wedded to a weakness for sharp curves, and this induces a tendency to remove flanges. It is a practice which has its advantages; sharper curves will be negotiated, to be sure, if the flanges of middle drivers of 6-coupled engines and 10-coupled engines, and the two pairs of middle drivers of 8-coupled units are removed. But there will be grievous loss of power, for it must be remembered that the flanges, as well as the treads, grip the rails, especially on curves, where there is an increased demand on the traction due to curve resistance of cars.

Adhesive Weight.

Probably by far the most important factor for hauling is that of the weight of the engine itself. Scores of models tested by the writer in past years have been built with no regard whatever to this important matter, and the results have been only too obvious. A recent example, however, showed that the builders had concentrated some thought upon the subject. This engine possessed a tender which was practically a solid lump of lead. In the front of it the apron which normally projects into the cab was arranged ingeniously to bear upon a lower plate at the cab base. The front truck of the tender was so loosely arranged perpendicularly that this was permitted. The smokebox end of the engine had another monopoly of weight so that, when the tender was removed, the engine literally tipped forward on to the leading truck spring. This meant that when the tender was in place there was a combination of all the weight of the engine and all the weight of the tender; the result was the best in hauling power the writer has yet seen. Literally, the exact amount of weight required is easily computed. A model should be first ballasted just up to the point where the drivers will not slip when the unit is impeded by the forefinger in front and the full voltage applied to the motor. At this point, the slightest amount of ballast should be removed so as to allow the drivers the slightest slip at the full voltage.

Wheelbases.

Curvature being as important as it is in model railroading, the length of rigid wheelbase is given. This will give you an idea of the comparative curvature each type requires. It does not always follow, however, that just because two types have the same rigid wheelbase they will take the same minimum curvature. Differences in leading truck arrangement will often affect this, but in general if a Pacific, for instance, will take a curve, a Hudson with the same rigid wheelbase will also take the curve.

Special adaptations of long wheelbase locomotives to curves should also be considered. On model railroads curves are often out of all proportion to those on the original. Those who build large locomotives must not lose sight of the fact that even on real railroads adaptation to curvature is necessary and so on models special measures will be even more needed. These measures should be logical steps such as those taken in the prototype rather than the lazy man's dodge of inaccurate gauge, sloppy guard rails, and such.

The Denver & Rio Grande Western runs its long rigid wheelbase high drivered 4-8-4's in fast passenger service over 12°-45′ curves in the Royal Gorge, but these engines have lateral motion driving boxes. The Pennsylvania M-1a Mountain type takes some pretty sharp curves, but it has no flanges on the two center pairs of drivers. All the articulated locomotives are enormous, and it surprises the novice to see some of the Western roads taking them around street car like curves in

the mountains. But articulated locomotives are specially designed to take curves, and they do it. The N. M. R. A. in its standards carefully analyzes the effect of curvature and suggests measures which allow full use of standards even with large locos and sharp curves, by following prototype practice.

For roads with heavy curvature one of the older types of passenger locomotive may be more practical, as will be seen by comparing various locos. The Atlantic is a happy compromise, a locomotive which is fairly modern and yet capable of taking the shortest curves. A heavy Atlantic can be used on way freights as well as short passenger trains.

Close coupled 80 ft. O gauge passenger cars will not work satisfactorily on less than 5 ft. radius curves, and with these curves one has the possibility of choosing almost any type of power. Many model roads run freight service only, because of short curves which will not accommodate passenger cars. However, with locomotives it's the other way around. Freight locos take wider curves than do passenger engines. A common fallacy, that the Consolidation will take shorter curves than the Mikado, is exploded. The rigid wheelbase for the two is about the same. The trailing truck, if properly built, will not make any difference. The Berkshire comes into the same class as the Mikado and the Consolidation in spite of its bigness. But the Mountain type has a longer rigid wheelbase just because it is usually built with higher drivers for greater speed.

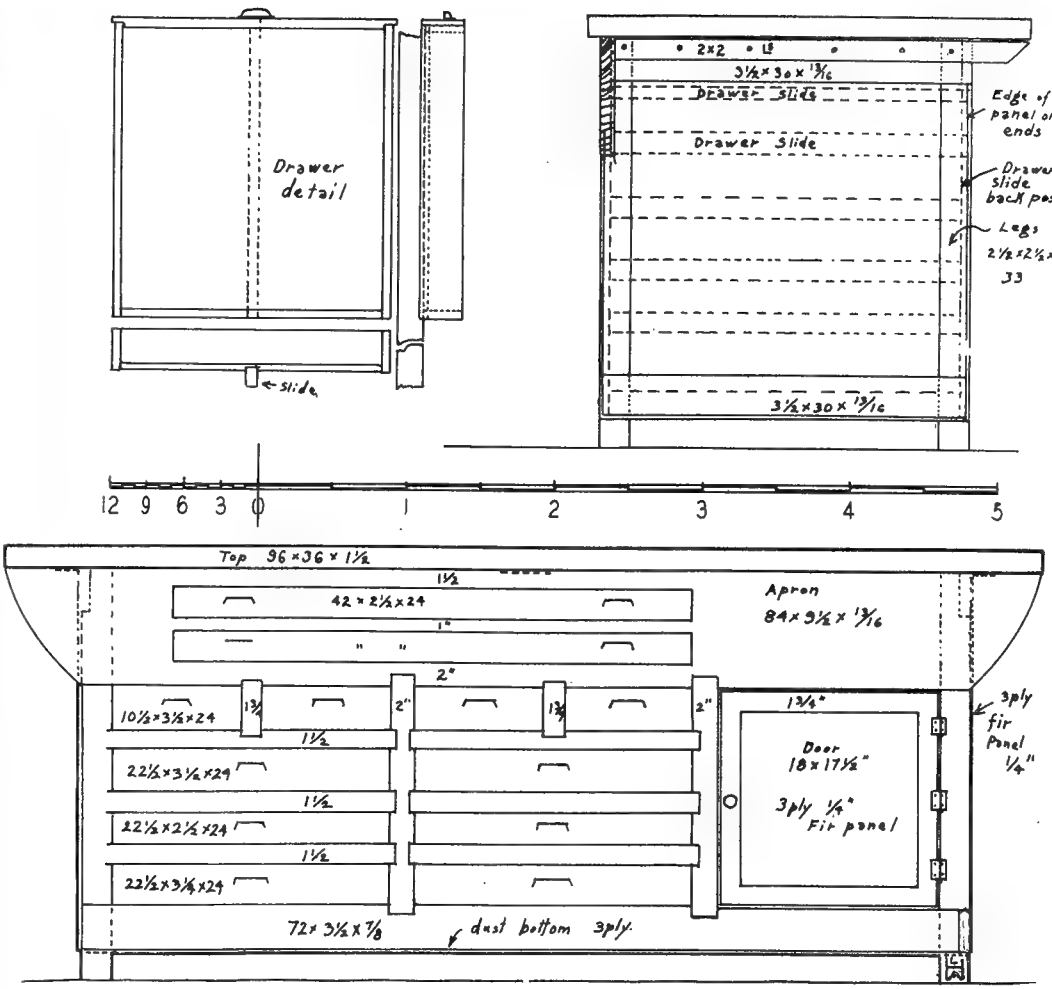
The articulated has only the rigid wheelbase of a Mikado, or if it's a double six-coupled job, much less. The overhang, though, can be tremendous. Clearance on curves must be watched even when the engine will stay on the track all right. But the articulated is the solution for those who want huge power but who haven't 10 ft. curves. We know of one O gauge 2-6-6-4 which successfully negotiates 2′-6″ radius curves.

Dual and Single Drive.

It is a much argued question whether it is advisable to have one or two motors on a locomotive of the two-truck electric type. The arguments against this procedure are that it is essential that both mechanisms shall be running absolutely in tune together or the one will waste power in driving the other; but on the whole this objection is more apparent than real. For while it applies when the faults of one motor are involved, it also applies where the superior running of the other is considered. That is, one motor will improve or tend to improve the defective running of the other. When such a pair of motors have been run together for some time it will be found that they tend to a natural synchronization more than to mutual impeding. And that hauling power is practically doubled there can be no doubt; this may be verified by an experiment in double heading. Two engines will certainly haul almost double the load of one. All that is necessary is that brush gear shall be made especially accessible, so that adjustments in this regard can be made easily.

Workshop Equipment.

It is not possible within our space to devote much attention to this aspect of our subject, which is really worthy of a special book to itself. The financial capacity of model builders varies so much that what would be valuable guidance to one would be a closed subject to another. An ideal workshop for our purpose may be regarded as a desirable luxury rather than a practical necessity. But in one photograph we show the workshop of Bernard Corbin, which would probably take a lot of beating. This little shop is equipped for every kind of wood or light metal working, and includes a lathe, grinders, drill press, lighting equipment and air compressor. These machines are driven by fractional horsepower electric motors. A useful bench design is given on page 35. This was designed by E. C. Chestor expressly for model making. It is heavily built, with a 1½″ top and 2½″ square legs. Side and rear panels and the dust bottom keep tools and parts stored in the drawers quite free from dirt and grit. Such a bench is ideal for mounting the light machinery which can be had from recognized dealers. But for the majority, machine tools of the more ambitious type will be found little more than the "desirable luxury," and for these there are certain useful expedients that may be adopted. One of these is that of the improvised lathe. Those who have an ordinary


Drawer detail
Slide
2x2
3½ x 30 x 13/16
Drawer Slide
Drawer Slide
Edge of panel on ends
Drawer slide back post
Legs 2½ x 2½ x 33
3½ x 30 x 13/16
12 9 6 3 0 1 2 3 4 5
Top 96 x 36 x 1½
1½
42 x 2½ x 24
1"
" "
2"
Apron
84 x 5½ x 13/16
10½ x 3½ x 24
1½
2"
1½
2"
1¾"
3ply fir Panel 1/4"
22½ x 3½ x 24
1½
Door 18 x 17½"
3ply ½" Fir panel
22½ x 2½ x 24
1½
22½ x 3¼ x 24
72 x 3½ x ⅞
dust bottom 3ply.

hand drill and various detachable auxiliary drills may find it a very useful idea to place the drill in a vise. To wind wire springs, for instance, a fastening is made with a loop around the special size of drill or a piece of rod, the wire being guided by the right hand while the left furnishes the motive power. Small articles such as wheels may have their treads turned off or smoothed. The wheel is chucked by the axle and a file is used for the turning, with a block of wood for a rest. A dentist's flexible shaft, and many other small surgical instruments, are invaluable to the model worker. The popular polishing head is also indispensable, especially for the removing of surplus solder in place of the old, tedious work of filing. Use a wire brush or a circular sanded ink eraser forced on to the head.

Useful Tables.

Below and next page are two useful tables, the first one compiled by Rollin Lobaugh and representing screw practice for model builders. To one building models, who is not familiar with screw thread practice, it is sometimes difficult to know the correct drill to use in drilling holes which are to be tapped. Although it is easier to find the correct size of drill for clearance, that also is information which sometimes must be ascertained.

The chart has been compiled with the thought of giving information at a glance which will be useful to all modelmakers, in that it shows the tap drill, clearance drill, etc., of all machine screw sizes from 0 to 12. The proportions for hexagon head screws are as close to National Screw Thread Standard as it is possible to make them with the sizes of hexagon rod available.

It will be found that if screws in the correct scale, according to proportions given below, are used in the same position on the model as are bolts on the prototype, the desired effect will be obtained.

The chart shows dimensions of the heads of hexagon screws only. Heads of fillister head screws are approximately the same size but heads of flat and round head screws are slightly larger in diameter.

During the construction of a model it is usually necessary to assemble and dismantle it several times. If fillister or round head screws are used during the construction, they can be easily turned in or out and facilitate the assembly. Then, in the final assembly, hexagon heads may be used.

The other table is a most useful scale reduction chart for the four popular gauges, including also the 17/64" scale for O gauge.

Locomotive Testing Track.

A further scheme, devised by the writer, is that of a testing track of a portable kind for trying out engines in the workshop during construction. It is shown on page 38 and is very easily made up, consisting simply of a 3 ft. length of appropriate track mounted on a hollow base, with wood bumpers at the ends forming part of the structure. The one in the plan is for HO gauge. For larger scales the base and track might be longer. The whole thing can be screwed down to a side bench, and has on its surface the track, a section of checkrails to test wheel clearances, and a ramp of whatever approved type is used for uncoupling cars. Power is supplied by a flexible cable, and there is an on-off, a reversing, and a speed control switch. For these, radio switches are used. The introduction of this feature into the shop will save dollars in shoe leather and much leg weariness caused by running backwards and forwards to the nearest section of the layout in order to carry out running tests. Its main advantage is that it can be screwed down anywhere you want it. Coupling and uncoupling can be tested under power, which is better than testing by hand.

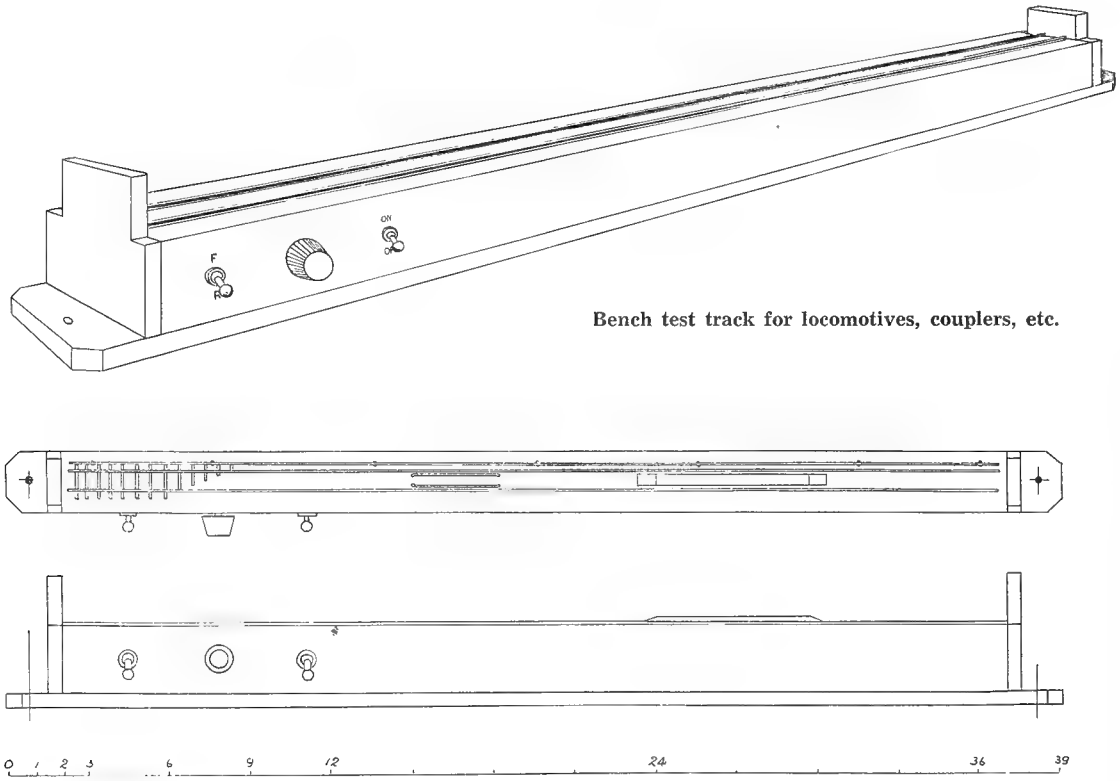
Plans for locomotives are available from a

TABLE OF HEX-HEAD SCREWS AND THEIR SCALE SIZES.

Screw Size	Threads per In.	Max Outside Dia.	Tap Drill	Clearance Drill	Dia. of Head	Height of Head	SCALE PER FOOT AND 1/4"	3/8"	1/2"	SIZES OF BOLTS 5/8"	3/4"	1"	1½"	2"
0	80	.060	55	52	3/32	.040	2 7/8	2	1 1/2	1 5/32	31/32	23/32	31/64	23/64
1	64 or 72	.073	53	48	7/64	.055	3 1/2	2 11/32	1 3/4	1 3/8	1 5/32	7/8	37/64	7/16
2	56 or 64	.086	49	43	1/8	.064	4 1/8	2 3/4	2 1/16	1 21/32	1 3/8	1 1/32	11/16	33/64
3	48 or 56	.099	45	38	5/32	.075	4 3/4	3 11/64	2 3/8	1 47/64	1 37/64	1 3/16	51/64	19/32
4	40 or 48	.112	42	32	11/64	.084	5 3/8	3 37/64	2 11/16	2 5/32	1 51/64	1 11/32	57/64	43/64
5	40 or 44	.125	37	30	3/16	.093	6	4	3	2 13/32	2	1 1/2	1	3/4
6	32 or 40	.138	34	28	7/32	.104	7 7/64	4 27/64	3 35/64	2 21/32	2 13/64	1 25/32	1 7/32	57/64
8	32	.164	29	19	1/4	.125	7 7/8	5 1/4	3 15/16	3 5/32	2 5/8	1 31/32	1 5/16	63/64
10	24 or 32	.190	23	10	9/32	.140	9 1/8	6 5/64	4 9/16	3 21/32	3 3/64	2 9/32	1 33/64	1 9/64
12	24 or 28	.216	15	2	5/16	.160	10 3/8	6 29/32	5 3/16	4 9/64	3 29/64	2 19/32	1 47/64	1 19/64

Scale Conversion Table

Full size	17/64″ scale inches	1/4″ scale inches	4 mm. scale millimeters	3.5 mm. scale millimeters	1/8″ scale inches
1/2″	.0111	.0104	.1640	.1435	.0051
1″	.0222	.0208	.3332	.2916	.0104
1 1/2″	.0333	.0313	.5000	.4375	.0156
2″	.0442	.0417	.6468	.5735	.0208
2 1/2″	.0554	.0521	.8332	.7291	.0260
3″	.0665	.0625	1.0000	.8750	.0313
3 1/2″	.0776	.0729	1.1668	1.0209	.0365
4″	.0887	.0833	1.3332	1.1666	.0417
4 1/2″	.0998	.0935	1.5000	1.3125	.0469
5″	.1108	.1041	1.6668	1.4585	.0521
5 1/2″	.1219	.1145	1.8332	1.6241	.0573
6″	.1330	.1250	2.0000	1.7500	.0625
6 1/2″	.1441	.1354	2.1668	1.8960	.0675
7″	.1552	.1458	2.2332	2.0416	.0717
7 1/2″	.1663	.1562	2.5000	2.1875	.0781
8″	.1772	.1667	2.6668	2.3235	.0834
8 1/2″	.1874	.1771	2.8332	2.4790	.0885
9″	.1995	.1850	3.0000	2.6250	.0888
9 1/2″	.2106	.1979	3.1668	2.7710	.0939
10″	.2217	.2083	3.3332	2.9166	.1042
10 1/2″	.2328	.2187	3.5000	3.0625	.1089
11″	.2437	.2267	3.6668	3.2085	.1135
11 1/2″	.2549	.2396	3.8332	3.3541	.1193
1′-0″	17/64″	1/4″	4 mm.	3.5 mm.	1/8″
2′-0″	17/32″	1/2″	8 mm.	7 mm.	1/4″
3′-0″	51/64″	3/4″	12 mm.	10.5 mm.	3/8″



Bench test track for locomotives, couplers, etc.

good many sources, one of best being the Model Railroader Cyclopedia.

Prototype Designs.

This includes locomotives of all common types from a good many different railroads. Most of the locomotives are typical of others of the same classification on different railroads. The U. S. R. A. locomotives deserve special remarks. These locomotives were built by the government during the World War (1918) and were put into service in many parts of the country. Many of the types were built in both heavy and light designs, the difference being mainly in boiler and wheel sizes. There is probably no more typical Pacific, Mikado, Switcher, or Mountain than the U. S. R. A. jobs. Many other locomotives built later have the same basic specifications.

Building a Scale HO Pacific.

In order to show the process of building your own locomotive from plans using a minimum of manufactured parts (because they are not available) we have chosen to reprint a series of articles by Frank Taylor on the construction of a U. S. R. A. heavy Pacific in HO gauge. The original is in use on the Erie RR. Heavy Pacifics in use on other roads differ only in small ways such as the arrangement of piping and feedwater heater. The fact that the described model is built to 3.5 mm. scale is only incidental, for the methods used in making the various locomotive parts is exactly the same for O gauge and OO gauge equally well.

Materials Commercially Obtained.

The only parts to be bought are the motor, couplers, wheels, axles and gears. These can be bought so cheaply that making them will not be considered. The rest of the model will be made up from sheet brass, bar and wire. If modeling in HO order six 23 mm. drive wheels from your dealer. You will also need two pairs of passenger car wheels, 10.5 mm. in diameter for HO, and a set of 30:1 gears. W. K. Walthers has shouldered axles for his wheels and can supply a bakelite gear to fit the axle. The worm is of brass. A pair of couplers and a Mantua, Varney, or Pittman permanent magnet motor should also be obtained. And in order to start construction, a supply of brass should be on hand at that time. The following will be useful: about 3 ft. of .013″ H. H. (half hard) sheet brass; 2 ft. of ⅛″ x ¼″; some 1/16″ and 1/32″ thick (about

6″ square will be enough). ¼″ x ¼″ and ⅛″ x ½″ are two other sizes used.

As some of you may have rather sharp curves on your pike, perhaps it will be best to leave off the center wheel flanges. But for curves above 3 ft. radius HO or 5 ft. radius O gauge this is not essential.

Frame and Bearings.

The frame (below) will be split and have individual bearings. After trying other known methods, this was found to be the best. Split bearings would be ideal, the big drawback being that they are not available in sizes that we can use. The next best thing is to use a bearing made of brass tubing, which can easily be replaced. If the bearings were simply drilled in the frame, a repair job would not be so simple.

If you will notice, three slots are cut in the frame. Ordinarily a milling machine is used to cut the slots because this method insures that the axles will be parallel with each other and with the frame, which means that after they are mounted, all of the drive wheels will be in contact with the rails. Your chances of accomplishing this by drilling through the frame itself are not so positive.

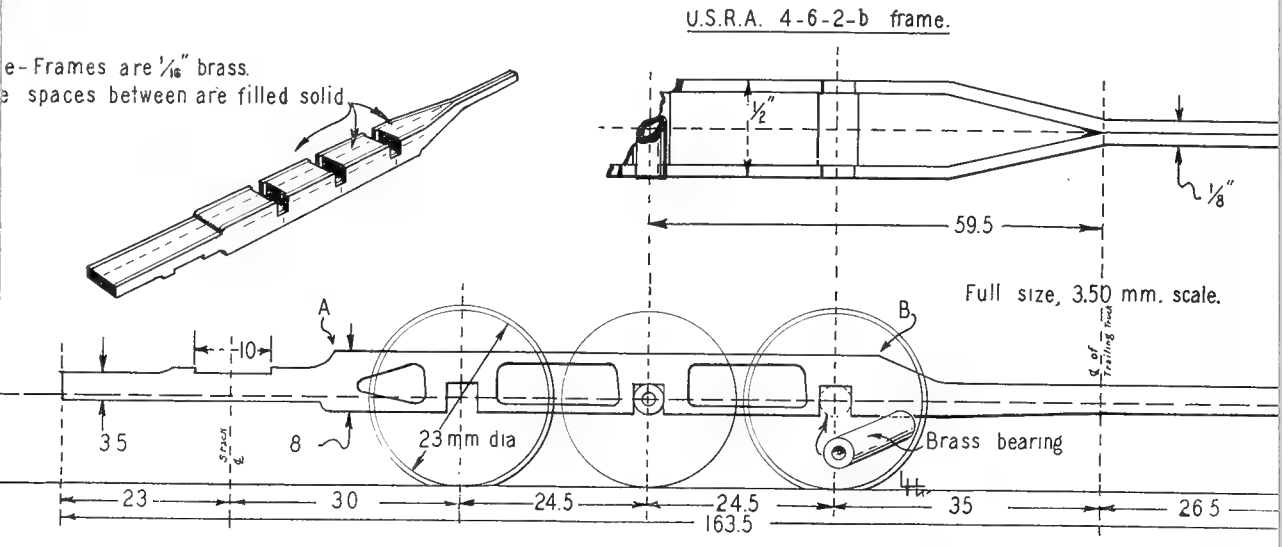
We now require some suitable brass tubing; 5/32″ o.d. would be ideal for bearings, the inside diameter being slightly smaller than the axle diameter. This will allow for fitting. The drawing shows how these bearings fit into the frame.

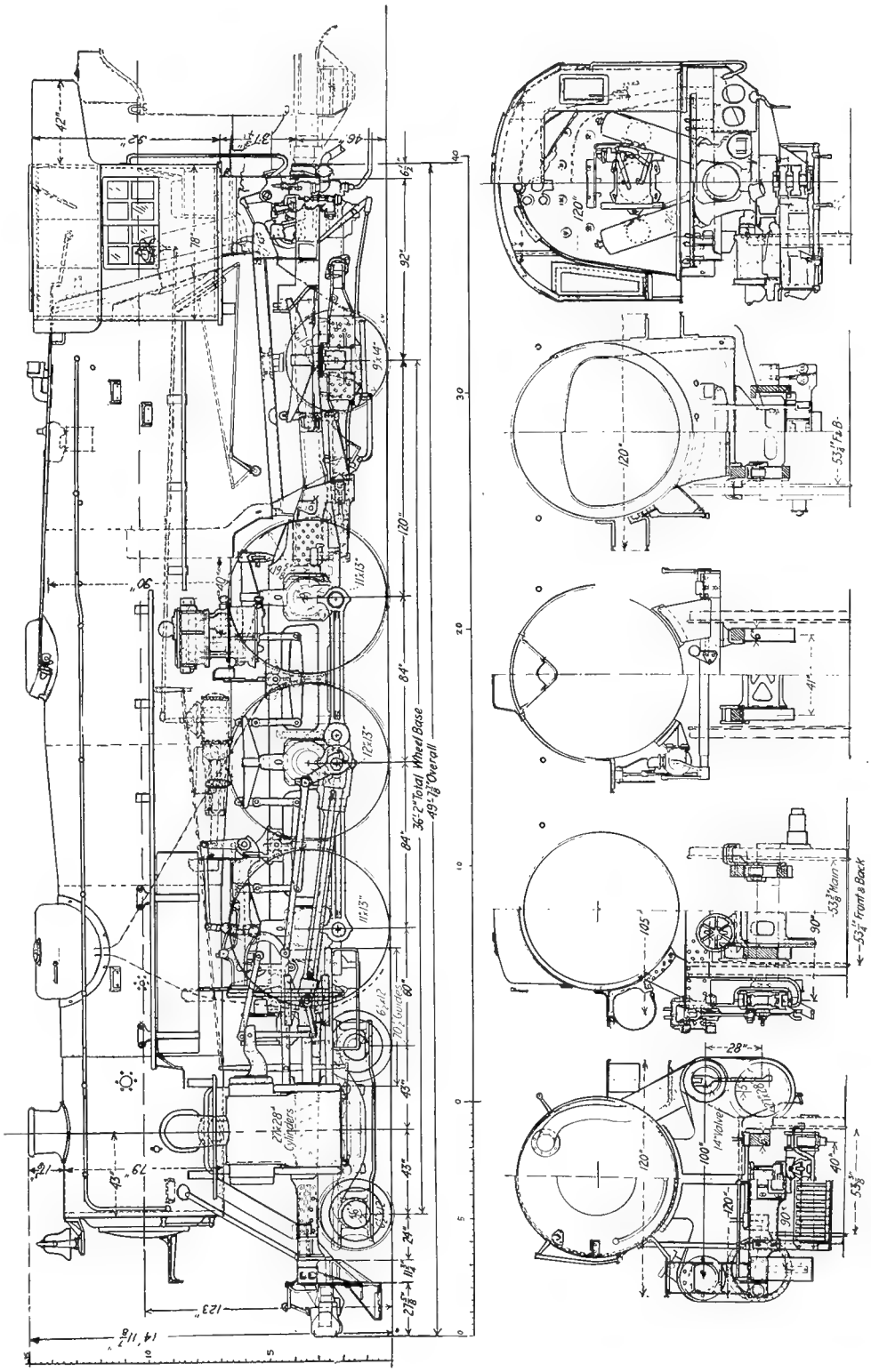
The bottom of the frame will have to be drawn in as shown so that the bearings can be held in place by a sub-frame. The rest of the frame outline can be scaled down from the original drawings. If you will check the frame drawing against the original drawings, slight variations in outline will be noted. As these are of no consequence, it was thought best to simplify the frame to some extent. You may go further along this line if you wish.

There are a few measurements that are critical and should be borne in mind, such as the clearance between the trailing truck axle and the bottom of the frame. Note how the frame tapers off at the rear to a point where this axle is located (top view). This design gives maximum strength to the frame and a bigger possible swing for the trailing truck. The coupler height must also be maintained, so be positive that the outline is drawn correctly at the front. Measure up and down from the drive wheel centers for all such locations to avoid errors.

Pilot Beam.

The erection drawing (opposite) should be carefully studied. Notice that the details for the pilot beam are shown on the left half of the section to the lower left only. The right half of the same is a cross section through the cylinder, lead truck, etc., and may be ignored for the present. It is sometimes confusing to read the drawings, especially if they have been reduced in size. The shape and location of a certain part may not show clearly enough on the cross section to help you understand what it really looks like. Checking section against elevation often helps to clear this up. Certain lines can be checked by set-

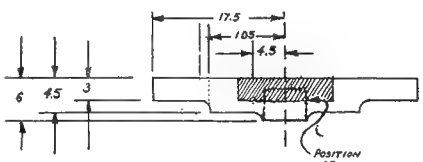




Plans of the original U. S. R. A. Heavy Pacific. Full HO size.

ting one point of the dividers on the rail line and the other point on the line in question. Without changing the setting, the dividers can be used to locate this same line on the side elevation.

The pilot beam can be made of ⅛" x ¼" brass. A piece 1½" long will suffice. Measure ¾" from one end and scribe a line across the face of the piece. Use this as a center line. By using the dividers, mark off the width of the coupler pocket and the start of each step shown in the front view of the pilot beam. The over all width of the beam can also be marked off. Measuring each way from the



Pilot beam.

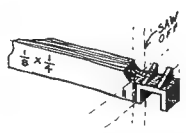
center line for these locations helps to insure accuracy. The lines to be scribed lengthwise on the piece had best be done by setting the combination square to the desired depth and using this as a guide for the scriber.

After a piece has been laid out as shown here, file down to the lines. Do not file out for the coupler until the coupler pocket has been filed and soldered in place. The front of the frame should fit the ⅛" x ½" notch (shown shaded) in the pilot beam. When sure that the beam is square with the frame, solder them together. File clean. The outside edges of the beam can be slightly rounded.

A piece of ⅛" x ¼" brass is also used in making the coupler pocket. A good way to fashion a small piece like this is to cut the stock long enough so that it can be held in the vise and then leave just enough stock sticking out so that it can be easily worked or filed on all sides except one. This method will allow you to file a pocket to the shape shown.

Coupler Pocket.

Before soldering this to the pilot beam, a plate (shim stock) 4 x 6 mm. will have to be cut. This can be soldered in place and then cleaned up. The coupler pocket can be laid on this plate and perhaps held in place with a battery clip while soldering. Do not use too much solder, but hold the iron on the work until you see the solder flowing. In this case it is suggested that the soldering be done from the bottom so that the fins of the pocket will not fill up. Using the slot already filed in the pocket as a guide, file through the pilot beam so that the coupler shank will be able to lay flat. The sketch shows the coupler pocket.



Coupler pocket.

The slot for the gear can now be laid out on the frame. This can be ¼" wide by 11/16" long. Drill three or four holes to remove most of the metal and then file to the scribed lines. A piece of ⅛" x ½" brass can be cut 2¾" long for the sub-frame. Scribe a center line down its length and then clamp it to the frame, edges flush with the sides of the frame, and locate so that each end is equidistant from the center axle. The four holes to be drilled can be laid

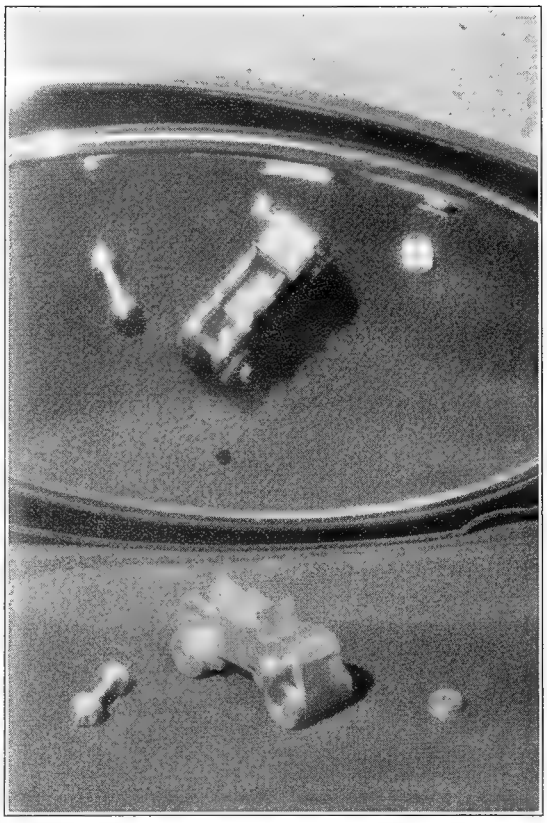
Gear Slot and Sub-Frame.

The frame showing pilot beam and coupler pocket in place; also cylinder block with turning partly pushed in.

out making use of the center line just scribed. Be careful not to locate these in an empty space over the frame. After center punching, drill with a No. 50 through the sub-frame and a little more than half way through the frame. Take off the clamps and re-drill the holes in the sub-frame with a No. 42. Tap the holes in the frame 2-56. Four ¼" R. H. brass machine screws can be used to fasten the sub-frame to the main frame.

The hole filed in the frame for the gear must also be made in the sub-frame. This can be laid out on the sub-frame by scribing through the hole in the frame while the two

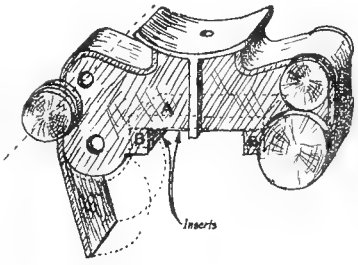
are bolted together. Then drill out and file as before. Notice that the gear is enclosed. Cut a piece about ¼″ wide and ¾″ long. Curl it and solder one end to the sub-frame at the edge of the opening. Use the cut-and-try method until the cover will just clear the gear when the latter is in place. Then solder. Sides of cover are of the same material. Solder these in place and file to shape.

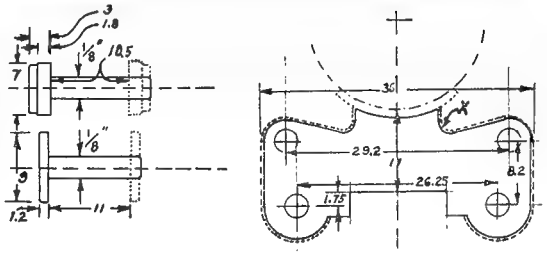


Cylinders, Cylinder Block and Saddle.

Using a piece of 1/16″ brass, roughly 1″ x ¾″, lay out the front of the cylinder, using the same cross section drawing used in making the pilot beam. Use the right half this time for cylinders. As usual, scribe a vertical line. From this find the center line of the cylinders and of the valves. Notice that allowance has been made for the material to be wrapped around so that when everything is soldered together the over all measurements will be correct. This is made clear in the sketch.

Certain other measurements must be kept; for example, the relation between the center



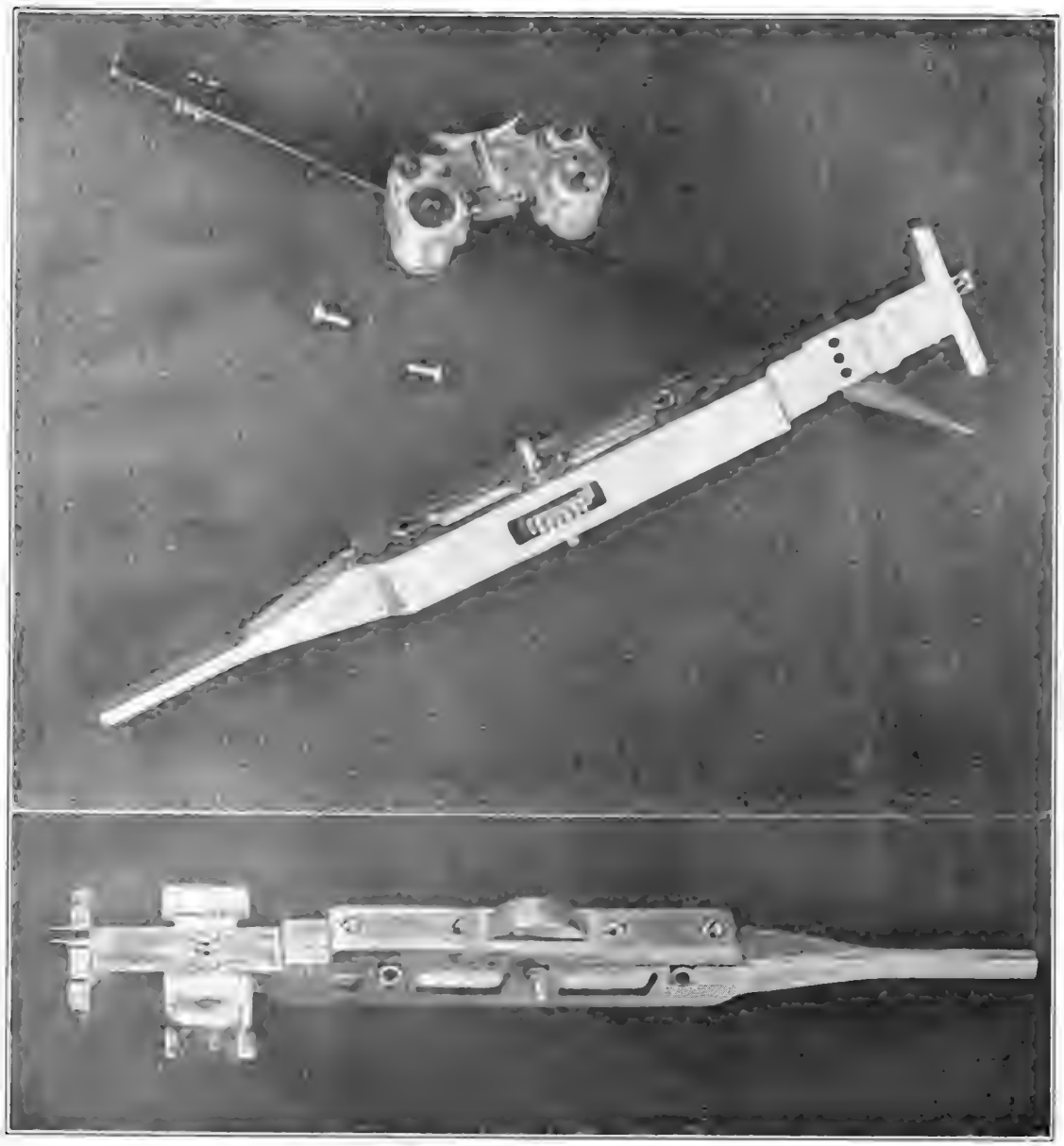


Details of the cylinder block and the method of construction. Above, photo of same.

of the cylinders and the surface that will rest upon the top of the frame. The saddle for the smoke box should also be placed correctly so that the over all height of the model will not deviate from that shown in the drawings.

After the saddle piece is laid out, solder it to a black piece of brass (the same thickness) and file both to the scribed line. A spacer of ¾″ square brass should be lined up so that it also forms the surface coming in contact with the frame. Use a battery clamp to hold in position. When correct, solder together. Two pieces of ⅛″ square brass can be fitted and soldered in place to form BB. The solder is cleaned off to offer a nice fit for the frame. No. 60 holes are now drilled ⅜″ deep in the centers of the turnings having stems (valve heads) and No. 50 holes are drilled in the piston heads. The valve and piston rods work back and forth in these holes. They do not necessarily have to be turnings but turnings are recommended. Pieces of brass of the right thickness can be filed to the correct size and soldered individually in their respective places as an alternative. The turnings shown are inserted in the No. 30 holes and the caps either forced or soldered in place on the other side.

The stock to cover the sides can be made of shim stock (.008″ or over). Cut two strips about ⅜″ wide and solder them in place. Start at the saddle position and work around and



Nearly full size picture of frame, cylinder block and gear installation.

down underneath until the strip contacts with the ⅛″ inserts. The reverse curve beneath the saddle is easier to negotiate at first rather than at the finish. In fact, the sharp curve (X) can be bent over a scriber before starting to solder. A small fillet of solder can be flowed around the turnings and then cleaned up to improve the looks somewhat. The material for the saddle can be 1/32″ brass cut into a strip ½″ wide. Before cutting to length, bend this strip over a pipe of the right diameter so that the correct curvature is obtained. Now cut the piece so that it measures ⅝″ across edge to edge. Set this piece in position and solder. Two pieces of 1/16″ square brass can be soldered in the position shown to complete the cylinder block. Clean it up nicely with a file.

A couple of machine screws are used to fasten the cylinder to the frame. They are 2-56 F. H. (flat head) ¼″ long. Set the cylinder in position and lay out the locations for these. The photograph shows their positions. After center punching, drill No. 50 through the frame and the ¼″ square insert. Redrill the holes in the frame No. 42 and

countersink. Tap the holes in the cylinder block. Now assemble.

A No. 42 hole is drilled clear through the frame and the cylinder block. A screw will eventually pass through this and screw into the smoke box, thus holding the two together. This hole will have to be laid out so that it will pass exactly through the center of the cylinder block. Turn the assembly upside down and carefully find the center of the frame (side to side) and of the cylinder block (front to back). Center punch. Now carefully drill through, making sure that the frame is square with the drill in each direction. The drill should pierce the saddle in the exact center. Countersink from below.

The holes for the crosshead guides can be drilled in the cylinder gaps at this time. A line should be scribed on each lower cap (rear ones). This should be parallel with the frame side and cross directly through the center of the caps.

Valve Hangers.

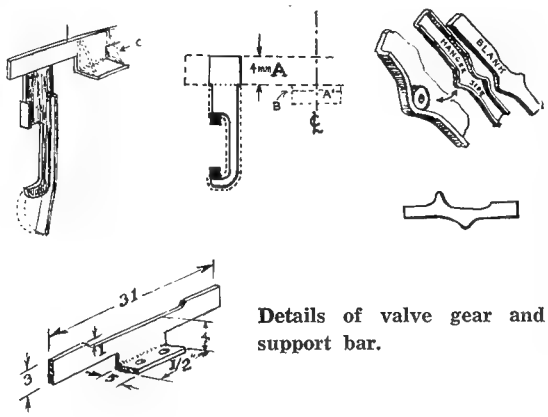
A valve hanger of the type shown (Baker) can be built up in a number of different ways. The figures show the method used to bring out some of the detail. The blank used to form the valve hanger sides was made of 1/16" sheet brass. In laying out the blank from the drawings, allowance is made for the thickness of the metal that was bent over the edge of the blank in forming the side so that the finished hanger side is not oversize.

After the blank is carefully filed to shape, cut four pieces of .013" sheet brass large enough so that when placed against the blank, enough metal is allowed for peening over. Now clamp the two pieces (blank and material) in a vise and bend the edge of the material over the blank edge. Start at one end and work to the other. In order to stretch the metal so that it will follow the contour of the blank, a piece of round rod can be used, tapping it with a hammer until the metal is formed to the desired shape. The hammer alone can be used to bend over the material at the straight portions. File off any of the bent flange that hangs over the blank before taking out of the vise. This is so that when the parts are turned around to form the opposite flange, the excess of the first flange will not interfere with the closing of the vise.

On the finished hanger side, the flanges need not extend out more than 1/32", so after the forming has been done file them down to this size. Make two left and right side pieces. The yokes are made of 1/32" sheet brass. The dotted lines show the outline of the flanges to be soldered to the yoke edges. Thin shim stock cut 1/16" wide is suited for this purpose.

Yoke and Support.

The yoke support (see sketch) is also made of 1/32" sheet brass. The top of this is 6½ mm. above the frame when in position. The support is 4 mm. at A, the tongue in the center is bent at B to bring the piece up to the desired height. This tongue can be ½" wide (width of the frame) and the yoke support



Details of valve gear and support bar.

is 36 mm. wide over all. Notice the two braces (marked C). These are merely put on for looks and are of .013" stock. The drawing shows them dotted. Solder the yoke to the support at this time. A piece of ½" brass is used in making the rear hanger support. It is made much the same as the yoke support. The dimensions shown in the perspective will help you to lay the piece out. The one operation left to do before the pieces are assembled is the bending of the outside hanger sides.

The second cross section in the U. S. R. A. drawing shows the yoke, yoke support, and also the spacing for the hanger sides. This drawing will also help you when bending the sides to shape. The S bend in each outer side should give a clear space of about 2¼ mm. between it and the respective inner side. Solder the straight side to the bent side at the rear.

The hanger sides can now be soldered to the yoke support. Solder from the top and bottom rather than from the sides to prevent the solder from filling in between the flanges of the hanger.

A battery clamp can be snapped over the yoke and the yoke support to prevent this joint becoming unsoldered. This brings out a good kink.

Forethought is necessary in order to solder the right part on first. For example, if the hanger sides had been soldered to the hanger support first and the yoke soldered in place afterward, the first joint would have come apart due to the proximity of the parts soldered. A clamp could not have been used to hold the hanger sides in place while the second soldering job was done.

Clamp the assembly and the rear hanger support to the loco frame. Shift the rear support until it is in correct position for soldering. Again refer to the drawings. Then solder together.

Now center punch the two mounting brackets for the four 2-56 round head screws. Screws can be used to screw the assembly to the frame.

The bearings shown on page 44 can be soldered to the hanger sides. A piece of round brass rod about 3/64" in diameter is held in position and then soldered. This piece can be a convenient length to hold without burning the fingers while soldering. After soldering, snip the piece off close and then file flush with the flange of the hanger side. This forms the round boss. Center punch and then drill No. 74. A bank pin fits nicely in a hole of this size.

The arms fastened to the rear of the hanger support can be scaled from the drawing and cut from .013" brass stock. A No. 74 hole should be drilled in the upper end of each arm. The other end can be drilled No. 53 so that a piece of 1/16" diameter brass rod can be inserted and soldered. This rod can be filed off flush with one side of the arm and extends out about 3/16" on the other side.

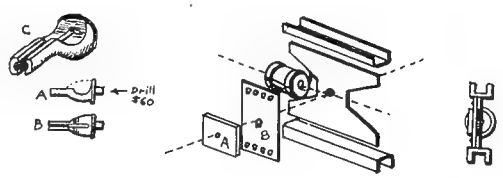
A small piece of brass can be fashioned into a bracket and used to fasten the arm to the rear hanger support. Study the photos and drawing. The shape of the bracket is not critical. Two brake cylinders are turned to the shape shown. The crosshead guides are shown in the drawing.

Crossheads, Guides, and Pistons.

While the cylinder is detached the two turnings (shown) can be made and soldered in place. The measurements for the turnings can be taken directly from the drawing. The holes in the cylinder block can be enlarged so that the bosses of the turnings will fit into them. A No. 60 hole is drilled through the center of the turnings. After soldering them in place, a round file can be used to file them in the shape shown in A.

Fasten the cylinder block to the frame again, sliding the crosshead guides into position in doing so. The guides should be soldered to the yokes. Enough clearance must be left between the yoke and the guides so that the crossheads will be able to slide back and forth at this point. The guides should also be parallel with the top of the frame. A little filing will correct any errors before soldering.

The crossheads can be made in a number of different ways. The method decided upon

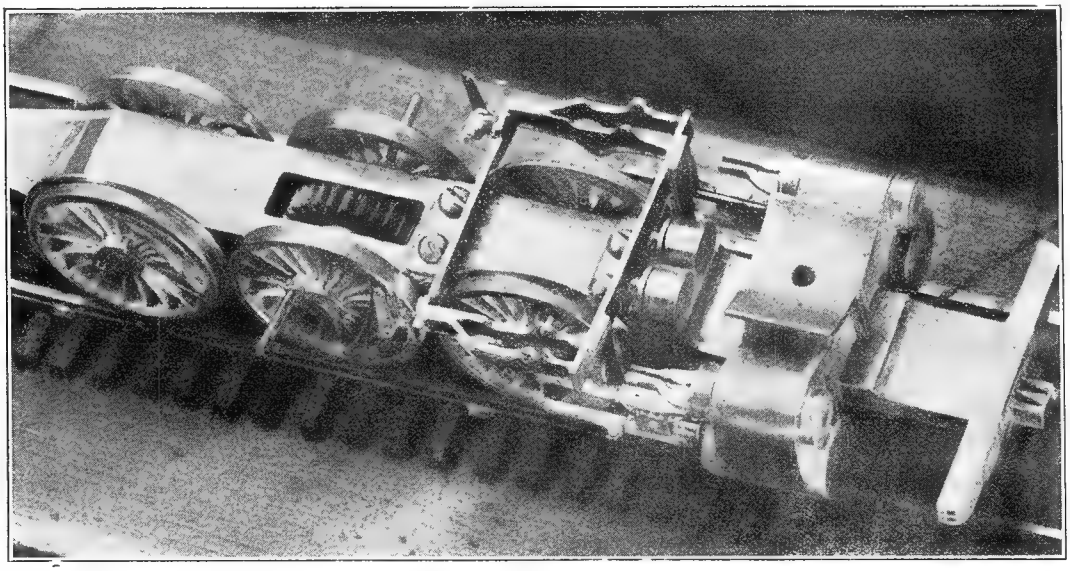


End for valve chamber of cylinder block and crosshead assembly.

is shown above. Sheet brass .013" thick was used for all pieces except A, which was of 1/32" stock. Handling the job in this way allowed the eight bolt heads to be punched in piece B. No dimensions are given because of the ease in which these can be obtained from the sketch. The small turning is soldered on last. When this is done work the crossheads in on the guides so that they travel freely. A good material to use for this operation, if nothing else is at hand, is valve grinding compound.

The piston rod is of drill rod or cold-rolled steel. An ordinary nail can be used. It should fit freely in the hole drilled in the cylinder block for this purpose. With the crosshead and piston rod in place, solder these together.

Four of the wheels to be used for the front



Top view of chassis and valve gear.

and rear drivers should have the crank pin holes enlarged with a No. 56 drill and tapped 0-80. The other two are drilled with a No. 53 or 1/16" drill for the brass rod shown. About one or two thousandths is plenty for a force fit, so check the diameter of the axle and the size of the hole in the drive wheel. If the difference varies more than this, drill out the center hole in the wheel to the correct size. Take the parts to a machine shop for checking if you are not equipped to do this. The center drive wheel flanges can be turned off at this time.

Fitting Wheels.

Assuming that two 14 mm. and two 3½ mm. bearings have been prepared and that the wheels and axles are ready, press a drive wheel on each axle. A drill press, lathe, vise or special jig can be used for this purpose. Keep the center drivers separate from the others because of the larger holes drilled for the crank pins.

The drive wheels are to be quartered on the axles; that is, the right wheel will lead the left by a quarter of a turn or 90°. To accomplish this, press the second drive wheel on part way; set the unit on the bench with the crank pin of the wheel facing you down and in line horizontally with the axle. The crank pin on the opposite wheel should be to your right and vertical with the axle. The wheel can be turned with the fingers to the correct position and then forced "home."

Remember to slide the bearings on the axle before pressing on the second wheel. The center set will need the gear pressed on between the two bearings beforehand.

Cut two pieces of 1/16" round brass rod about ½" long and solder these to the center drive wheels after forcing them into the crank pin holes. Do the soldering from the inside and clean off with a file.

Remove the sub-frame and install the wheels and then replace the sub-frame. Now you have something rolling.

Boiler.

The boiler is made in four pieces of .013" brass, wrapped around a wooden form, turned slightly undersize to allow for the thickness of the metal. To get a start on this feature, the drawings of the prototype should be scaled down as shown on page 48. Then the wooden core is turned to size. While this is still in the lathe, revolve the piece while holding a pencil against the work to mark the places where each section or taper starts and ends. Do not cut off the center marks made by the head and tail stock as these will again be used after the brass stock is wrapped around the core and soldered together. Putting the work back in the lathe will allow you to scribe four quartering lines on the length of the boiler with a surface gauge, using the bed of the lathe to work from. This is done so that the stack, domes, running boards, etc., can be located properly. Now make four templates

of cardboard so that each one will just show the pencil mark when wrapped in place on the core. Using these, lay out the shapes on the brass material and then cut out with the tin snips. As the material has some spring to it, the pieces had best be bent around something of smaller diameter first and then slipped in place on the core. A hot, well tinned soldering iron should be used, using plenty of solder. After the boiler is soldered together, clean off most of the solder with a rough file, then finish the job smooth with a finer cut file. You may then use emery paper on it, if you wish. Don't forget to scribe the lines.

The motor will be geared up to the center drive wheels. In order to provide clearance for the motor shaft, a slot will have to be cut in the boiler as shown in the photos. This measures 10 mm. wide and about 50 mm. long. Use one of the scribed lines on the boiler as a center line when laying out the slot.

A piece of brass for the center section on page 48 can be filed down to the following dimensions: ¼" x 5/16" x 1 3/16".

Pilot Truck. As shown, a hole should be drilled with a No. 50 and tapped 2-56. This hole can be drilled clear through the stock. Next, pick out a piece of 1/16" x ¼" brass and lay out two pieces, each 1 5/16" long. After these are cut off with a hack saw and then filed square, lay out the positions of the holes for the axles. This will be made easier by referring to the sketch.

Remember the trick of soldering two blanks together to eliminate the job of laying out two pieces of exactly the same shape and size? This was used in laying out the frame and can be used in this case. Centerpunch where the scribed lines intersect and then drill a hole just a little larger than the diameter of the axles you intend to use. The centerpunch mark in the center should be drilled No. 50, then countersunk for a 2-56 flat head machine screw and tapped. The two pieces can now be unsoldered and cleaned up with a file. Twirl a large drill in the holes to remove any burrs. The pieces are ready for assembly. Use ¼" 2-56 flat head screws. Screw one into each side piece tightly to lock it and then turn these into the center block all the way. Then back off about a half a turn for easy action.

Dummy equalizer bars are made to the shape shown. The contour behind the wheels is not to scale for obvious reasons. The purpose of these bars is to hide the heads of the flat head screws and perhaps add a bit more detail to a type of truck that is rather plain appearing. Some locos have lead trucks with outside frames and bearings. This type naturally allows for more detail. Use 1/32" brass stock for the two equalizer bars. Again solder two pieces together to save time in laying out and for more accurate drilling of the pieces.

The original drawings specify 36" wheels for the lead truck. After receiving these wheels it is suggested that they be dull nickel plated for the sake of appearance. Centers are painted black; rims are left unpainted.

The truck can be assembled as shown in the photos. The part of the axle that sticks out beyond the wheel hub can be filed or ground off flush.

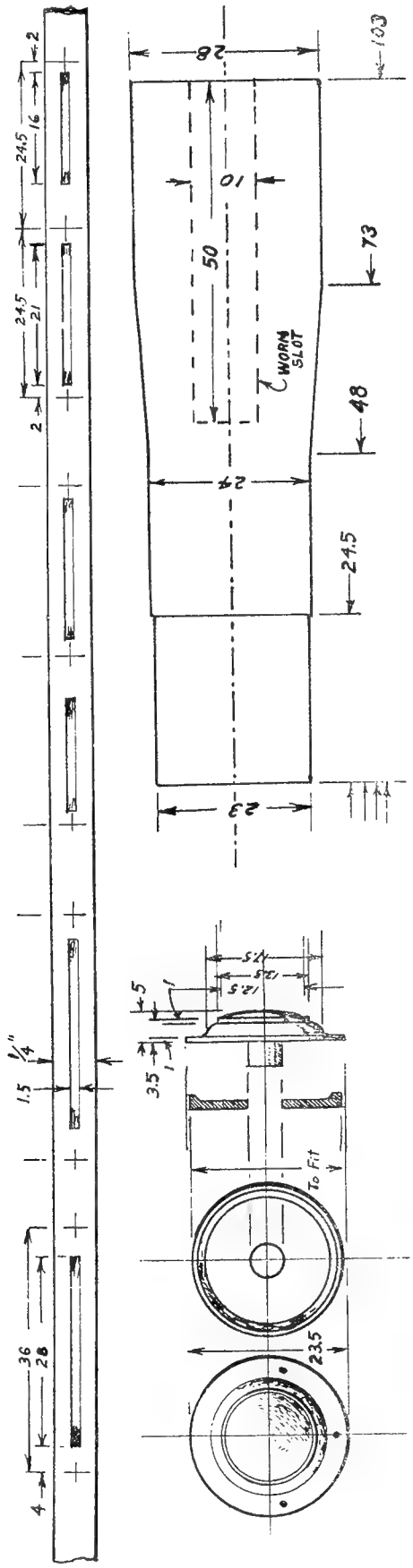
The first steps can now be taken for the main and side rods. A piece of 1/16" x ¼" brass stock about 10" long is laid out according to the measurements and the slots milled with a 3/64" cutter. This milling, if done at all, should be done before the rods are filed to shape. The cut should be half as deep as the metal is thick.

Main and Side Rods.

One other turning remains to be made at this time, and that is the smokebox front. In fact, it is made up of two turnings, as shown. The reason for this is that the piece to be drilled for the rivets, etc., can be turned quite thin to prevent drill breakage. The photos show the recess that was also provided for. This forms a cavity between the two pieces when they are fitted together. No difficulty should be encountered in the making of the two simple turnings. Just follow the measurements. Notice the lines scribed on the front of the smoke box. These will help to space the rivets, line up the hinges squarely, etc., and can be put on while the piece is still mounted in the lathe.

Smoke Box.

The measurements for the HO cab can be taken directly from the prototype drawing,

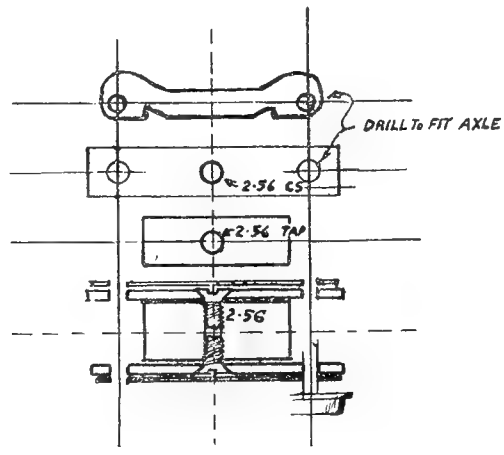


Milled brass ready to file into side rod shapes. Boiler and boiler front sizes. Below: Leading truck frame.

as it is exactly right size for HO. The cab sides are laid out on .013″ half hard brass, one left and one right. Use the edge of the brass stock for the bottom of the cab sides. This will place the window openings far enough from the edge so that they may be cut without distorting the material. Allow a 1/16″ lip on the top for soldering. The window openings should be cut out before cutting the cab sides to size. This is done by clamping the side between the jaws of the vise so that the line to be cut is flush with the top of the jaws. Cut along this line with a sharp chisel. A cheap 1/4″ wood chisel will serve. Loosen the jaws and give the piece a half turn. After the top and bottom edges are so sheared, do the same to the sides of the windows. These cuts are best made just inside the scribed lines; then file the openings to the lines.

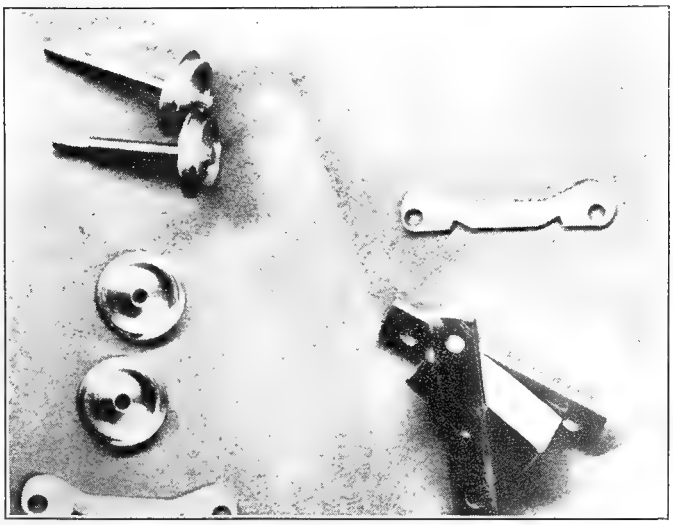
Cab.

In making the ends the same procedure is followed. Use the dividers to find the radius of the roof on the drawing and transfer this to the metal; cut out the window and firebox openings with the chisel first. Take small cuts, resetting the work in the vise after each cut. Finish with a file and flatten out. To solder the sides and ends together a simple jig will help. This jig as shown has no definite dimension. The necessary feature is the 90° angle. Clamp a cab side to the bottom board of the jig. Be sure that this piece is pushed up against the wooden upright. One of the ends is held flat against this upright for soldering. Be sure that the window of the cab side is in correct relation to the end it is being soldered to, also that the bottoms of the side and end are flush. After the sides and ends are soldered together, look the job over. If



slightly out of square bend to shape with your fingers.

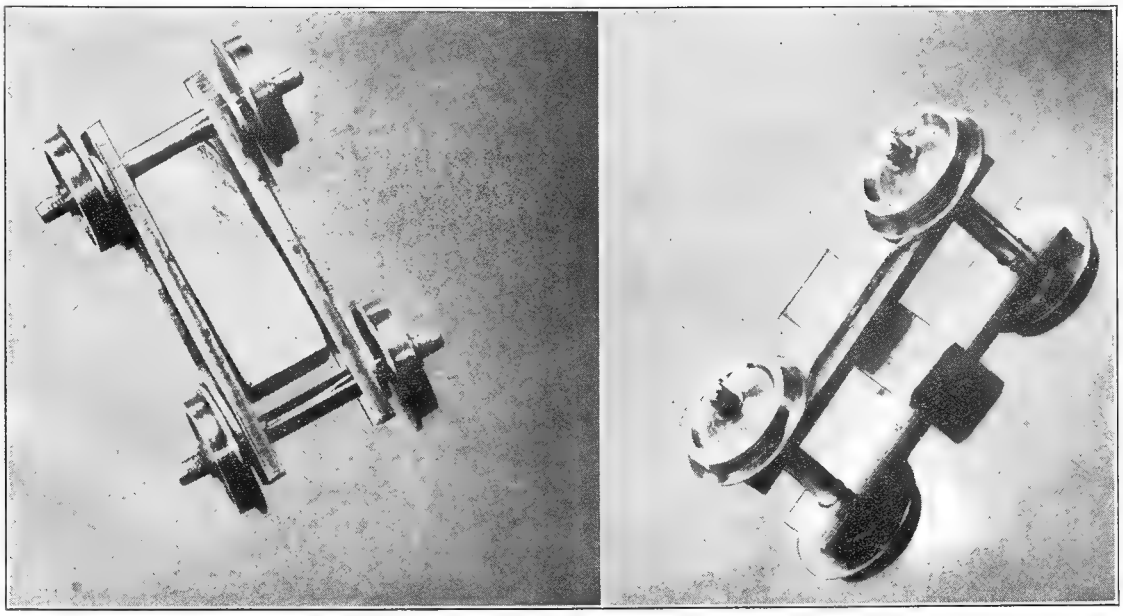
The roof can be laid out by making a template of paper or thin card first and then transferring this to the metal. Lay one edge of the paper in place (just above the window of the cab side) and then wrap it around the curved edge of the end to the other side and mark off. Measure this to find the size or width of the stock necessary to cover the roof properly. Divide this in half to get the center line. Also measure the length of the roof and then lay the measurements out on paper. The overhanging corners of the cab roof at the rear are tapered off toward the center line. Lay this out on one corner of your template and then crease or fold the template at the center line and cut out. Both sides should be the same.



Parts for the equalized pilot truck.

Now lay the template on a piece of brass stock and transfer the outline to it. Don't forget the center line. The roof can now be cut out with a tin snips except the curved portions which can be filed to shape. To curve the roof to its proper shape bend it around a piece of pipe of the right diameter. Notice that the cab roof projects over the cab proper at the front. A line can be scribed on the under side of the cab to show this. The center line should also be scribed on this side.

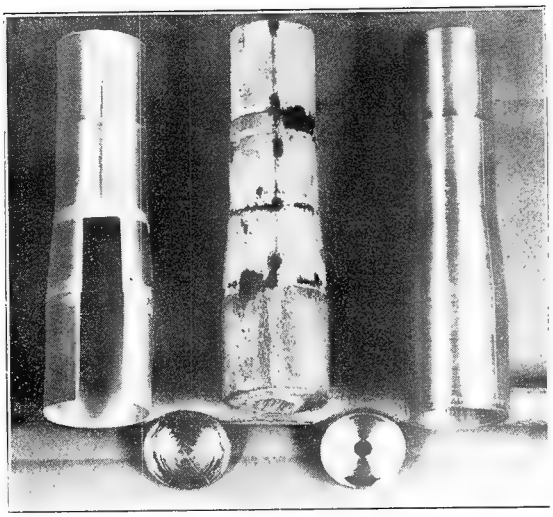
Lay the roof upside down on the bench and place the cab assembly in place. Tack the front of the cab to the roof, first making sure that the center line of the roof matches the center line of the cab front and that the roof projects the correct amount. Finish soldering the roof to the front of the cab. In doing this press down on the cab assembly so that a good fit is obtained between the roof and the cab front. The back of the cab can be



The completed pilot truck.

soldered to the roof in the same manner. The edge of the roof is soldered to the sides of the cab at this time. This soldering should be done inside the cab if a neat appearing job is desired. File the outside surface of the cab.

Fire Box. The fire box is simple to make but rather difficult to explain. The lines of the drawing shown on page 52 have all been given letters to make the job easy. Using .013″ brass, scribe a center line (CL), next scribe line D at 90°. In referring to the prototype drawing it will be noticed that the top of the fire box slants downward toward the rear. To obtain this slant a little figuring will be necessary. Locate Q so that the distance between D and Q equals the radius of the rear end of the boiler. Locate this also on the prototype drawing.



Two types of boiler and forming core.

CD then equals the amount of drop between the front of the fire box and point Q. The distances between D RS and D LS each equal one-quarter the circumference of the boiler at the rear.

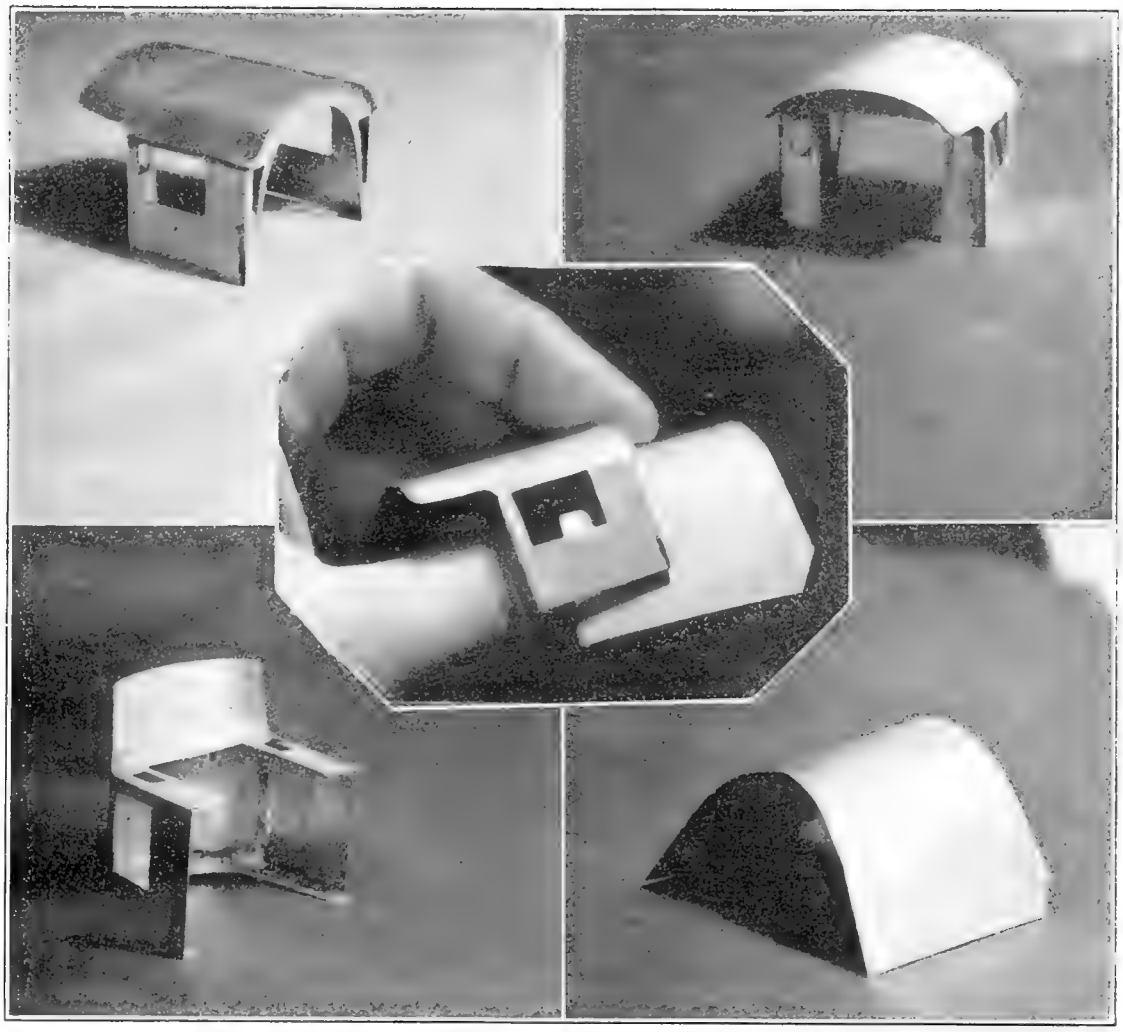
G can be located by measuring from C. This is not critical as it locates inside of the cab. H and F are located next. G to H and G to F are equal to one-quarter of the circumference of the fire box at the rear. H to LS and F to RS can be measured from the drawing. The contour between A, J, H and LS is also obtained from the drawing. The same goes for B, E, F and RS. You have finished the hard work when you have the design. Now cut out with a tin snips and shape it over a pipe or tube. Try making the template of paper first and most important of all, try to understand why the different steps were taken in the order given.

The fire box, having been laid out and cut to size, can now be bent to match the radius of the rear of the boiler. This can be done by bending the piece over cylinders or pipes of different sizes until the right shape is obtained. As the metal tends to spring back slightly, a pipe of a smaller diameter than the boiler should be used to compensate for this. After bending, the fire box should hold a true shape without any help on your part. If this thought is not carried out, a stress will be set up when the fire box and the boiler are soldered together, and breakage is likely to occur.

To solder the fire box and boiler together with the greatest of ease, it is suggested that the boiler be held firmly to a board with friction tape, rubber bands or string, so that your two hands will be free to hold the fire box in place and do the soldering. The center line of the fire box should be lined up with the corresponding line of the boiler and the two parts soldered together at this point. The unit can now be unstrapped from the board and looked over for any sight misalinement. The parts should stand some adjusting without the solder joint breaking.

Working toward each side, solder down to the center lines. Do not attempt to solder directly next to the first solder joint for fear that it might become unsoldered. Skip a space so that the heat of the iron will not affect the first joint. Go back and solder this after the rest of the joint has been soldered. Put on plenty of solder and be sure that it flows. Don't pack it on. Using a rough file, clean off most of the solder and then finish down to the brass with a fine file. Fine files clog up readily when filing solder, so spare them as much as possible. Let the coarse ones do most of the work.

Referring to the prototype drawing on page 48, locate the position of the front of the cab on the fire box. Measure from the front of the boiler to this point and transfer the measurement to the model. Use the top center line in doing this. The cab can be set in



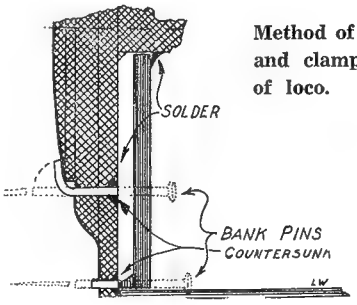
Cab and fire box views.

place and a solder joint made at the center. This will allow the cab to be bent up or down and twisted sideways if necessary so that it will eventually line up with the center lines on the boiler and fire box. When this is done, finish soldering the cab to the fire box much in the same manner as the previous soldering job was done. If you find it hard to work files in between the cab roof, front and fire box, use a wood chisel to remove most of the solder. The joints can also be scraped clean with this tool.

In order to use different makes of motors, it might be necessary to flare out the fire box. If a wide motor is used, the flare will have to begin just above the center lines on each side in order to provide the proper clearance for the motor. The prototype has a fire box that does not flare at all. The cross section drawings show that it drops straight down from the center line at the front. Whatever power you decide to use, provide sufficient room for it as outlined above. A plate should then be soldered to each side of the fire box to close up the front. The photo shows this clearly. Measurements cannot be given because the flare or lack of it on the fire box will be different in every case. Just fit two pieces to your model and solder them in place. Use the same thickness material as for the fire box.

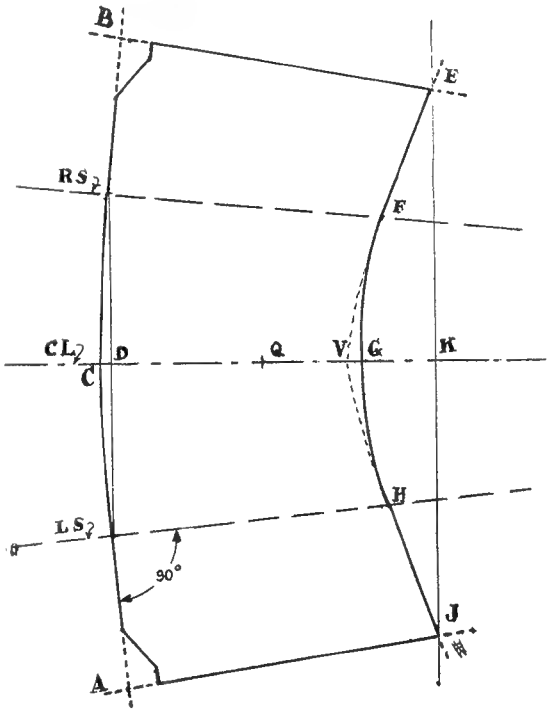
Running Boards.

In laying out the running boards it must be remembered that the measurement over the assembled boards (cross section) should be the same as the width of the cab. To apply this, lay out the center section of the running board. First determine how long it will be.



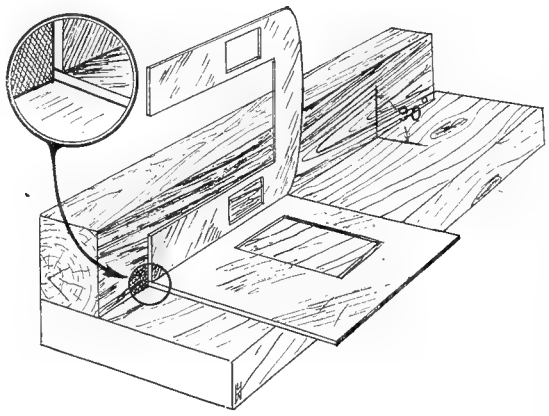
Method of representing rivets and clamps on boiler front of loco.

Below, firebox template.



Scribe two marks on the side of the boiler to show its location and also show the height by measuring down from the center line and marking. By using a pair of calipers, the thickness of the boiler at the rear markings can be determined. The difference between this measurement and the width of the cab is the total width of the running boards at this point. Divide by two for the width of one board. Lay this out for a length to correspond to the fourth course. As each course has a slightly different taper, the length of each course should be marked off on the material. By using the calipers at the beginning of each course or taper, the width of the running boards can be determined as explained and then marked off.

If a tin snips is used to cut off the part, some curling is to be expected due to the action of the shears. This can be straightened out with the fingers and then lightly tapped with a hammer to the correct shape. If the final result does not fit snugly at all points, a little filing and the generous use of solder will hide the defects.



Handy aid for square-butt joints.

In soldering the running boards in place, start out by "tacking" one end of the board to the boiler or fire box. Adjust it for squareness, etc., and then fasten the board at several points avoiding any tendency to buckle. When this is done start soldering at or near one end and work toward the other. By this procedure a firm, smooth joint is made all the way.

Boiler Fittings.

The stack is a simple turning as shown in the sketch. By now you should have quite a bit of experience in taking the different measurements from the drawings so you should not have any difficulty in "picking them off." Locate the center of the stack by measuring from the front of the boiler and drill a hole just large enough for the lower end of the stack to slip into. This method of putting on the stack prevents it from shifting out of place when soldering.

Notice the washer. This is made of .013″ brass and is bent to lie flat on the smoke box. The hole in it is the same size as was used in the smoke box. Its purpose is to give the plate effect shown on the prototype. After the stack and washer are pressed in place, sufficient solder is run around the joint to form a fillet. A round file is used to form the correct shape. Clean around the plate or washer with a flat file or chisel.

The steam dome is turned to the correct size and placed in position. Just tack one end of this to the boiler to allow for adjustment before flowing solder around its base. Carefully form the fillet with a round file. The sand dome was left 'til now to give you some experience in squaring a dome and forming fillets. Although a bit more work is involved, this part really is not hard to make. The width, height, and length are figured from the drawing. In making the sand dome for the HO model, a piece of stock ⅛″ x 9/16″ x ⅞″ is ideal. After scribing the center lines, two semi-circles (shown as A on page 54) are scribed. Then file blank to shape. The cross section of the drawing shows the amount of metal to remove as shown in B. The center lines filed off in the process of shaping are again located.

A piece of .013″ brass is cut slightly larger than the block of metal previously shaped, as shown in C. This piece is curved the shape of the boiler and the block tacked to it. When this point is reached, the unit should be set in place and the front of the block raised so that it is level instead of slanting forward. This lifting of the front end of the dome should not affect the plate, which should lie flat on the tapered section of the boiler. View D in dotted lines shows where the solder should be flowed to fill out the shape of the dome. Excess solder can be filed off and the bottom plate trimmed and filed to shape. A fillet to meet this plate is shaped with a round file.

Now that the dome is finished, except for the edges to be rounded on top, it can be soldered to the boiler. Soldering at the front and rear should be sufficient. Do not try to flow the solder around the dome in one operation. Do it in easy stages, giving the metal time to congeal before adding more.

Mounting the Superstructure.

Except for a few parts which have to be made, our superstructure is about ready to be mounted on the frame. The photographs and drawings show these needed parts rather clearly.

The sills, which are soldered to the bottom of the cab, are made of .013″ brass stock. These are cut to a size so that when they are soldered in place they will project about 1/32″ out from the front, sides and back of the cab. The plate with six holes, shown on page 55, can also be made of the same material and bent to the shape shown. The holes in this plate are not necessary, just added detail. Leave them out if you wish.

The one other part left to make is of 1/16″ brass about 3/16″ x ⅜″ for HO. Double these last two dimensions for O gauge. This piece is soldered to the rear of the frame in the position shown in the photo, page 55. Before soldering the bent plate with the holes to the underneath side of the cab, it will be best to lay out and drill a No. 42 hole in the boiler directly underneath the stack. To do this correctly, find the distance from the center of the stack to the front of the boiler. This measurement should now be transferred to the bottom center line previously scribed on the boiler. Center punch and drill. A 2-56 flat head machine screw can be shoved through the frame and cylinder block and then through the hole in the boiler. Slip a 2-56 nut on the screw and draw it down tightly. The nut can now be soldered to the inside of the boiler. Do this carefully so that the screw does not become soldered too.

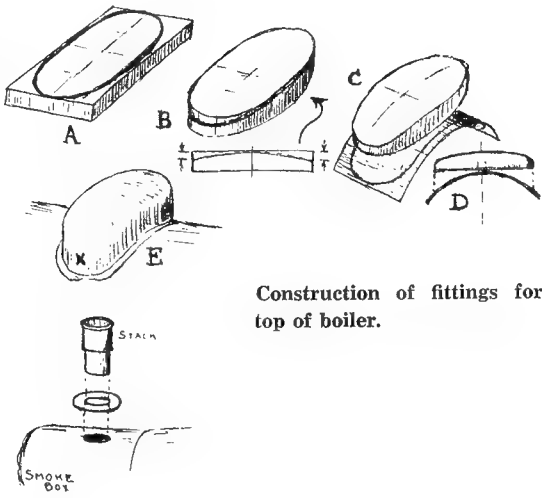
Now that the boiler is located and in position, the plate previously mentioned can be soldered to the two sills which make up the bottom of the cab. This plate should fit against the 1/16″ brass stock piece at the rear of the frame. Set the locomotive on a flat surface. Push cab up or down until running boards are parallel to the surface that the wheels are resting on. A small battery clamp can be used to keep the superstructure in position. Of course, this will hardly be strong enough to prevent the rear of the superstructure from shifting on the frame when the hole is drilled for the 2-56 mounting screw. It is suggested that the frame be lightly soldered to the back plate to prevent this. The battery clip will at least hold the parts in position for soldering. When this is done, drill a No. 50 hole through the back plate and into the rear of the frame. This hole can be about ¼″ deep. Break the soldered joint and enlarge the hole in the back plate with a No. 42 drill. Tap the hole in the frame for a 2-56 round head screw.

Now that the superstructure can be taken off or fastened to the frame at will, the next

job will be to clean off the excess solder. One of the ventilators to be put on the cab roof can now be cut to size. Dimensions can be taken from the prototype plan. Use .013" brass. Cut a piece out of the same material slightly smaller than the ventilator. Use this to shim up the ventilator so that a slight space shows between the ventilator and the roof. Solder only at the front and the rear so that the effect is not lost. The photograph shows this ventilator in position.

The motor can be mounted in many different ways. By using a heavy material for the bracket it was found that the simple method used and shown in the photo was sufficient for good operation. A piece of 1/16" brass, 1/2" wide, was bent at one end. Two holes were drilled to take the mounting screws of the motor. Set the motor in position after the worm gear is in place. The other bend in the bracket can now be marked off and formed. Two holes can be drilled through the frame and the lug or bracket. Enlarge the holes in the frame and tap the bracket the same as previously mentioned. This shaped bracket can only be used with a Pittman motor. A Varney or Mantua motor would require a bracket of different shape but the principle is the same.

In mounting motors that are a "tight squeeze" in a fire box, some difficulties might arise. Slip the motor into the fire box, then carefully set the whole superstructure with motor in place on the frame. Locate the position of the worm on the motor shaft and, after pressing or soldering this in place, repeat the above and mark off the position of the motor on the frame and also note the clearance between the motor and the frame at some certain point. Now make your



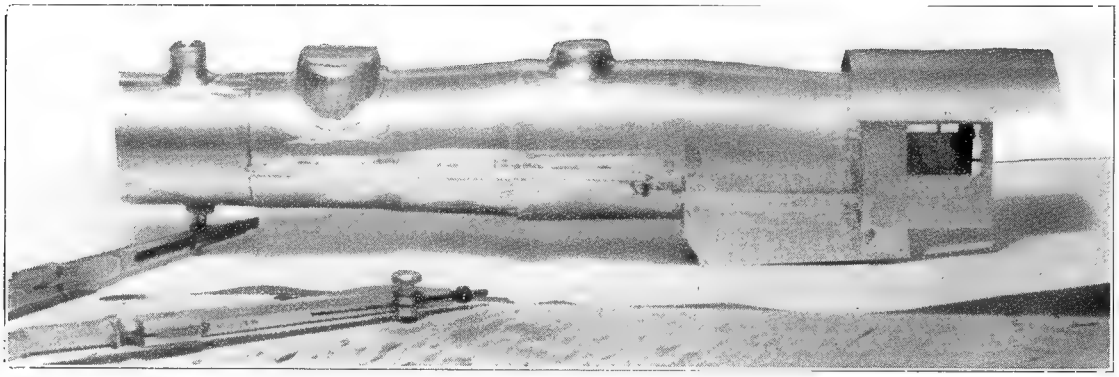
Construction of fittings for top of boiler.

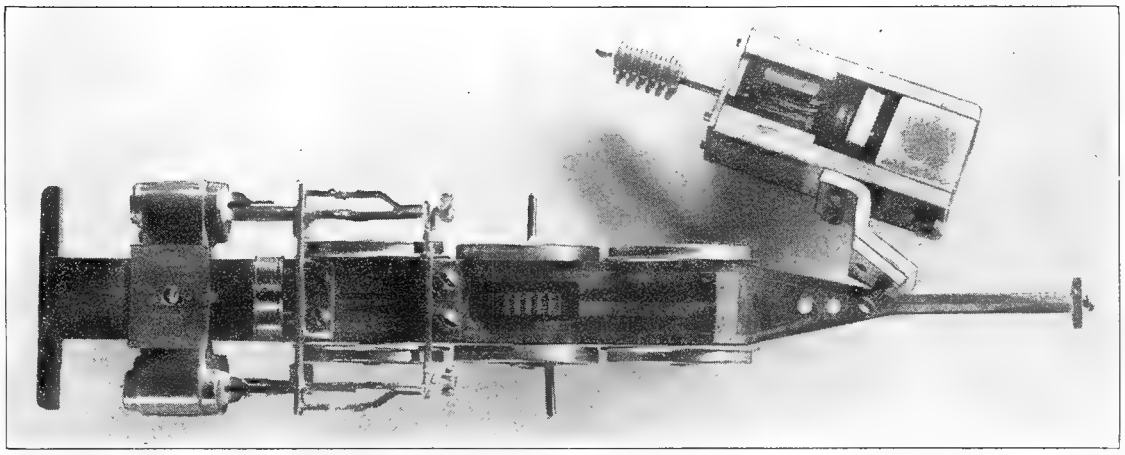
bracket so that it will hold the motor to the frame in the correct position.

Details.

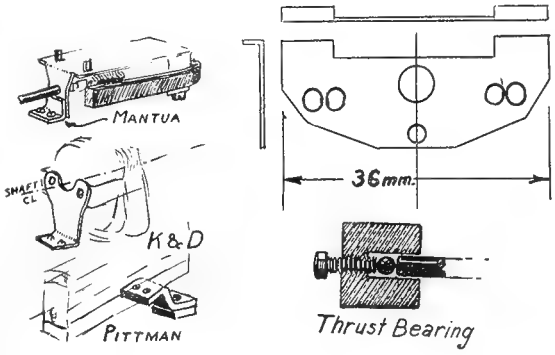
It will be sufficient to solder a band around the boiler at each change in the taper of the boiler. Start by soldering the band on one side of the boiler at the running board and then bend the band around the boiler and cut it off so that it will butt up against the running board on the other side. Solder in three or four places to hold the band in position, and be sure to clean off all excess solder.

Assemble the superstructure on the frame so that the two steam pipes that connect between the cylinders and the boiler can be fitted in place. These are in line with the center of the smoke stack. Use round brass rod for this purpose. Cut two pieces off to approximately the right length and then file the ends to conform with the shape of the cylinder block top and the side of the boiler. File the ends and then try the piece until a fairly good fit is obtained with the pipe sitting at the angle shown in the cross section





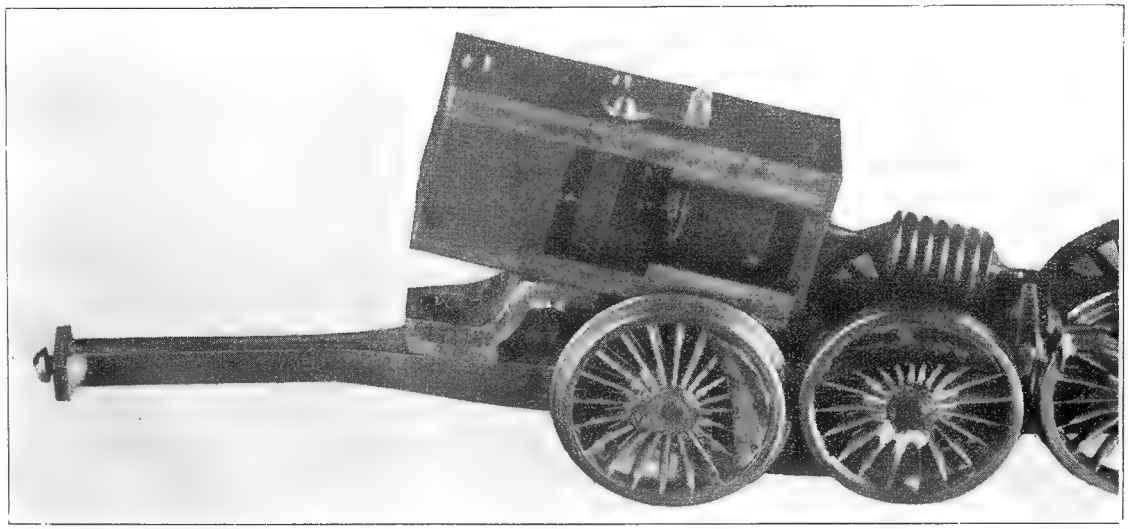
Method of mounting Pittman motor.



Above left: Motor mountings. Above right: Rear cab plate. Below: Thrust bearing.

view of the prototype drawing. Be sure the pipe rests against the boiler at the correct position, measuring down from the center line scribed on the side of the boiler. Both pipes should be the same. They can now be soldered to the top of the cylinder block, but are left loose at the upper end. Use a hot iron so that the job can be done quickly without spreading the heat to other parts of the cylinder block, thereby doing damage.

The photo on page 57 shows two round brass plates soldered to the upper end of the pipes. These plates, if you care to put them on, fit between the pipes and the boiler. In order that this can be done it will be necessary to carefully file away enough metal on the ends of the pipes to compensate for the thickness of the material used in making the round plates. Use .013″ brass, and cut off a strip slightly wider than the collars and about three or four times as long. Bend the strip around a rod to give it the correct curvature to make contact with the boiler. From this strip cut two pieces large enough to file out the round collars. Reassemble the frame and superstrucure, then slip the two pieces be-



tween the boiler and the pipes. Solder to the pipes, forming a fillet with the solder. Take off the superstructure and file the plates to shape. Also clean up the solder.

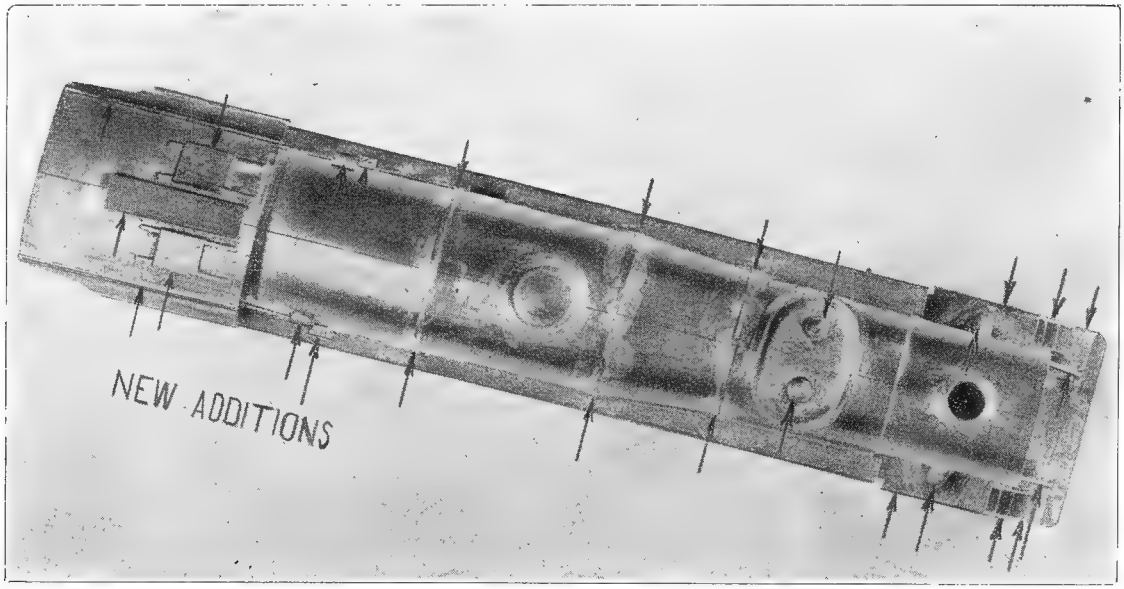
The running boards directly above the cylinders will be soldered to the steam pipes so that the steps placed between them and the plate on the front of the frame can be soldered firmly in position. If the running boards just mentioned were made a part of the superstructure, one end of the steps would have to be left unsoldered. This is a rather weak arrangement and should be avoided if possible, because the steps are likely to be banged up when the superstructure is taken off the frame for oiling, etc. A groove or notch will have to be filed in the running boards to allow them to slip over the pipes after they are cut to size. File the grooves deep enough so that the over all width of the running boards coincides with that of the running boards on the superstructure. Solder them to the pipes, making sure that they are square.

Two plates are now made of .013″ stock, cut long enough so that when placed against the side of the frame they will be flush with the end of the front beam and wide enough so that the bottom of the steps will rest on them when in place. This measurement can be taken from the drawing. Turn the frame upside down and lay the beam and part of the frame on a flat piece of wood. While in this position, set the plates in place and solder. In turning the frame right side up you should find that the plates have been soldered flush with the top of the pilot beam and the frame. File off any slight variation.

Steps.

The steps are tricky little things to make, but the job can be done by going at it in the right way. Brass .013″ thick will be used for all of the parts. Cut a strip of correct width and long enough so that the four side pieces can be obtained from it. Tip the frame over on its side and lay a piece in position against the running board and the plate. Scribe the angles and length desired. Cut with the tin snips. Make the other three, using the first one as a pattern. Try them to see that they fit in place. As there are two steps to be soldered in place, divide the length of each side piece into three equal parts and scribe the same angle at these points as was previously scribed for the ends of each side piece. Now cut out four steps and carefully file these all to the same length.

Lay a side piece on a flat board with the scribing up. Using long nosed pliers, place and hold a step firmly in position against the side piece and solder it in place. Be sure the step is in the right position and square with the board. If you move it while the solder is still hot, you're sunk, because the scribing will be covered up by the solder. Solder the second step in place in the same manner as the first. If, after inspecting, you find that one of the steps is slightly tilted, try bending it with the pliers. A battery clip or rubber



band can be used to hold the other side in place against the steps to complete the job. Don't hold the iron on the work too long. Clean off excess solder and tackle the other set of steps. The assembly can now be placed and soldered in position between the running board and the plate. A good, clean soldering job helps immensely in the appearance of the finished locomotive.

Rails and Braces.

The two slanting braces between the front beam and the boiler are made of drill rod. Two holes should be drilled into the plates so that they just miss the rear edge of the beam. Refer to the drawing for the proper spacing of these. Push the drill rod into the hole and solder from underneath. Bend the rod backward until the angle is the same as that of the steps. Two holes are drilled in the boiler to allow for the entrance of the rods.

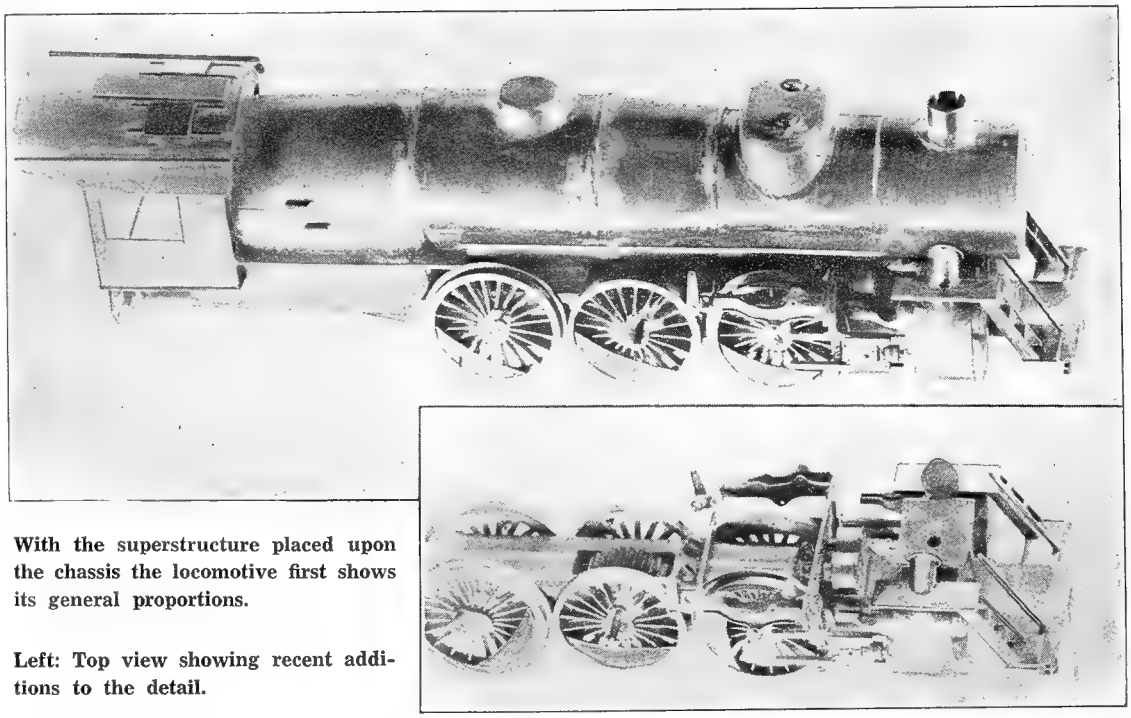
The holes for the hand rail holds can be drilled and a pair of trailing truck wheels obtained. Hand rail holders can be obtained from Gordon Varney. You will need two dozen.

Piping.

Care must be taken that the pipes be put on straight and the solder joints cleaned up. Also make the bends in the pipes neatly. If the photo shows a pipe bent at a 90° angle, don't copy it by bending the wire sharply for part of the curve and then finish the job with a wide sweep. It looks sloppy. Also let this be emphasized: If you want to do justice to the model, put the straight sections of pipe on straight. Avoid using iron wire because of electrolytic action.

On page 58 are the turnings required. Those not shown can be scaled from the drawing of the prototype. The air pump and the power reverser are each a combination of two turnings soldered together. Notice that after the turnings for the pump are soldered together, additional solder is piled up to allow the desired shape to be filed. This idea was followed in making the sand dome. A bracket can be soldered to the back of the pump so that it can be attached to the boiler. Curve or shape the bracket so that it will hold the pump in the proper position with the other end lying flat on the boiler. Solder in place. If you intend to put on the pipes leading from the pump, the holes for them should be drilled in the pump before it is mounted. The drawing shows the sections to be filed away on the power reverser turning. This method eliminates the necessity of soldering its crosshead guides to the body of the reverser.

The water conditioner is made up of two



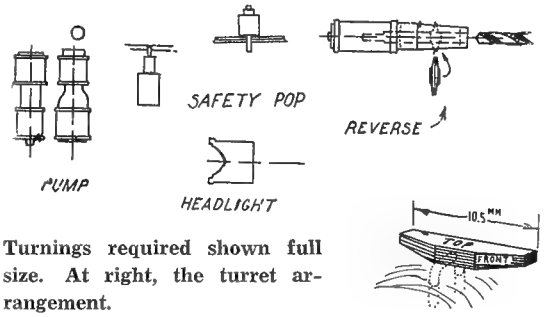
With the superstructure placed upon the chassis the locomotive first shows its general proportions.

Left: Top view showing recent additions to the detail.

turnings. The sketch shows method of assembly and the bracket used to hold it in position. The dimensions for the generator and bell can also be taken from the drawings of the prototype. These, after being turned, are mounted on simple brackets. The main thing is to mount them in their proper positions.

Water Conditioner and Bell.

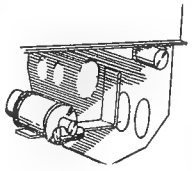
In order to mount the bell bracket, the smokebox front should be finished up. Although the front has been turned up, the rivets, etc., still have to be put on. Lay out, prick punch, and drill the holes for the rivets and the smokebox door clamps. The rivets and clamps are made by pushing bank pins through holes that are a snug fit (page 52). The pins are clipped off on both sides, the pin



Turnings required shown full size. At right, the turret arrangement.

heads being too large for a rivet head. After this is done, they are soldered from the back side and the solder cleaned off with a file. The holes on the back side had better be countersunk so that after the soldering is done and filed off flat, the space made by countersinking will still contain enough solder to hold the pins firmly in place. Do not clip the pins off too close on the front side; instead, file them down. The rear part or turning of the smokebox front has a hole drilled through its center. The lug on the rear of the front piece can now be pushed through this hole and the unit soldered together at this point. Slip the completed smokebox front in the smoke box, and, after truing it up, solder it in place.

The bracket for the bell can be made as shown in the photo of the Erie loco, or reference can be made to the drawing of the loco. You have two styles from which to pick. In either case, solder the bracket to the smokebox front before mounting the bell. It is quite



The water conditioner turnings are located under the left side of the cab.

a tricky thing to solder the bell hanger to the bell.

The bell can be made to swing back and forth by drilling through it and the hanger and then slipping a wire through the holes. Going to the other extreme, the bell hanger can be left off entirely. A tit can be turned on the bottom of the bell. This can be set in a hole drilled in the bell bracket and soldered in place.

The headlight is turned as shown on this page. Number frames are made of one piece of thin brass bent somewhat in the form of a triangle and soldered to the headlight turning as shown. After the headlight bracket is soldered to the smokebox front in the position shown in the main drawing, the headlight is soldered in place. Use long nose pliers to hold the headlight, and do the soldering with a hot iron. Get it over with in a hurry, before the heat spreads to the other soldered parts.

Headlight.

Just a few more words concerning the piping. Study the picture and notice the pipes that lie next to the boiler or fire box. Put those on your model first. It is also impossible to slip one wire under another after the one on top has been soldered in place. Notice that the sand pipes leading from the sand dome and the blob of solder that was afterwards carved to the desired shape. Solder can be used to fashion many parts that are hard to make in other ways.

In mounting the side rods on a two-rail job, it will be necessary to put spacing washers between the wheels and the side rod on the left side only. This is to prevent the insulated rim of the wheels on that side from shorting through the side rod.

Insulation for Two-Rail.

The two wheels on the left side of the lead truck are also insulated. The axle holes of these wheels are bored out and a piece of fiber forced into each of them. Holes are then bored into the fiber bushings and the axles forced into them. The insulated wheels

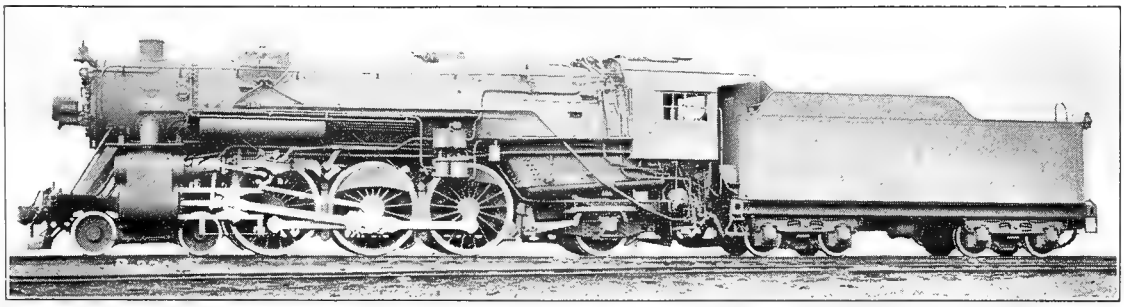


Photo of prototype at the time it was built.

should not contact the frame of the lead truck in any way. The fiber bushings can be made long enough to prevent this. The lead truck can now be mounted to the frame of the loco, using the method shown below. If, by trial, it needs to be moved forward or backward for maximum swing, this can be done by resoldering the wire connector in a new position. If the wheel flanges hit the frame in going around a curve, file away the frame at this point.

Ash Pan.

The ash pan can be made by using a piece of scrap brass. Its shape, with any corrections, can be transferred to another piece of brass to get the final result. It should be fastened to the top of the frame. This will allow the trailing truck to swing beneath it without interference. The superstructure will necessarily be put on and taken off several times in the process of fitting. The side edges of the pan should curl upward just outside the sides of the fire box.

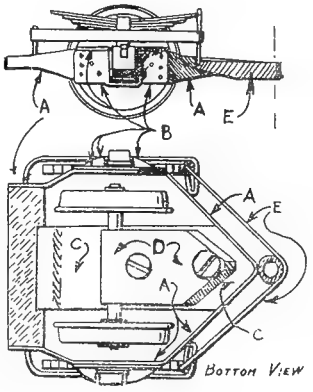
Trailing Truck.

The trailing truck wheels are turned to the correct size from brass rod; or substitute a commercial wheel somewhere near the right size. In any event, the left hand wheel will have to be bushed if for a two-rail system. The accompanying drawings show the construction of the truck. It was made so that the wheels can be dropped out and this was done for more reasons than one. The main reason was to dodge the rather difficult job of drilling the usual bearing holes in the journal boxes.

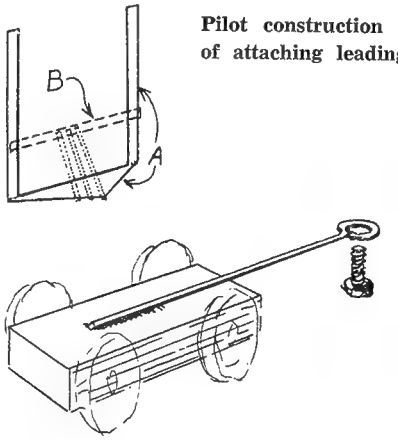
Notice that the axle rides on a central bearing rather than two outside ones. The axle protruding from each wheel acts as a spacer between the wheel and the journal box. Some side play was allowed. So much for generalities. To start construction on the side frame, two pieces marked A in sketch are made and bent to shape. Use .013″ brass or 1/32″ for O gauge. The two pieces marked B are cut out and bent to the shape shown. The rivets are brought out in these pieces by center punching from the back side. The plates are then soldered in place as shown. The journal boxes can be made using the methods described for making the coupler pocket.

After they are soldered in place, the two sides can be soldered to the wedge shaped piece referred to as C. This is made of 1/32″

Full size plans of the trailing truck.



Pilot construction and method of attaching leading truck.



brass, or 1/16" for O gauge. The trailing ends of the two sides are joined together, using a piece of 1/16" x 3/16" brass stock for a filler. The length of this piece is determined by setting the pair of trailing truck wheels in place and then measuring the gap between the sides at the trailing end. Solder this in place and then solder the wedge shaped bolster to it.

The clamp or bottom bearing of the axle can next be made. It is held to the bolster with 2-56 screws. The springs are made up of individual pieces and soldered together. A piece of 1/16" thin brass is wrapped around each one. Leave one end of this strip long enough so that the spring can be soldered to the inside of the side frame. Part E is made of thin sheet brass and is bent around a short length of 1/8" brass tubing. This assembly can be soldered to the front of the trailing truck. The brass tubing will act as a bearing for the pivot pin or screw.

The front of the spring can now be connected to the equalizer which we just attached. In actual practice one end of the spring of the rear driver is connected to the spring of the trailing truck, using the connections we have made and a few others which cannot be seen, for equalization. A good deal of faking has to be done at this point for our purpose, but the general effect is good. The two bars shown on the outside of the springs serve no useful purpose on our model but just looks. The drawing shows the way they are attached. The stock is 1/16" wide on this model. A 2-56 screw can be used to mount the truck on the frame. In laying out the hole for this screw, be sure that the distance between the center of the rear driver and the center of the trailing truck wheel is correct to prototype, a scale 10'-0".

Valve Gear.

The valve motion parts are made out of brass and are then plated dull nickel. Although some of these parts have odd shapes you should have no trouble in laying them out. By this time you have laid out enough locomotive parts from the prototype drawings to make this job easy.

With the valve motion completely assembled and installed, it is a good idea to work out any snags by rolling the chassis back and forth on a smooth soft board with the motor disengaged. When everything turns over smoothly, remount the motor and by making a few temporary connections run the job under its own power for a half hour or so.

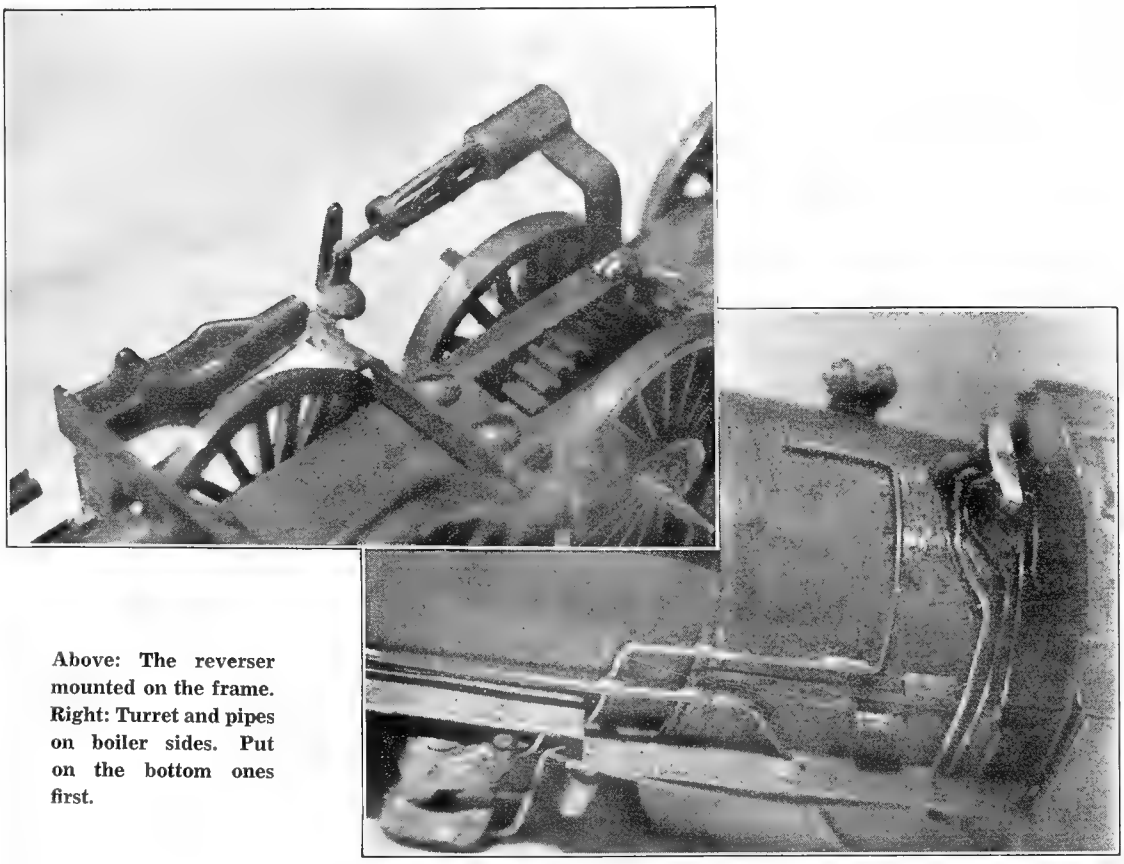
Vanderbilt Tender.

The standard square tank tender is used with this engine, but the Vanderbilt is just as acceptable and perhaps better appearing. We will describe the construction of such a tender. It may be built up around a brass tube, of the thinnest wall obtainable. Trim this to the correct length. Then scribe four center lines—one for top, one for base and one for each side. These help to locate the running boards. A cover for the rear end of the tender can be turned to shape. The front fuel compartment is separate, and a section of the tube is cut out to receive it. The over all width of this compartment is the same as the cab. Lay out a sheet of brass to form the bottom, slope and back sheets. The curve which forms the top of the back sheet can then be laid out. From the point where this scribing crosses the center line the first bend can be determined and then scribed. From this the second bend can be located. This bend will form the beginning of the bottom of the compartment, working towards the front. The front edge is found by measuring the length of the bottom. The piece is then bent at the scribed lines. Clamp it between the vise jaws for this purpose. The angles of this piece must be laid out on the tank. Care must be taken so that the bottom of this compartment is the correct distance from the center line.

A hack saw can be used to remove the section of the tube marked out and work is then dressed with a file. Use the center lines of the tank and the sheet to line up before soldering.

The two sides of the compartment are just flat pieces, no bends involved, and are snipped to shape in a jiffy. The same can be said of the front. Notice that the front sheet does not form a corner with the front of the side sheets; it sits in to the rear a bit. Do as much of the soldering as you can on the inside in assembling these parts.

As this compartment carries oil, the top will have to be closed in. Rather than bend



Above: The reverser mounted on the frame. Right: Turret and pipes on boiler sides. Put on the bottom ones first.

this up out of one piece, it is usually easier to use several pieces. To accomplish this, a piece of 3/16" square brass is soldered to the top of each side piece. The top surfaces of these square pieces are located at the right height so that the piece of sheet brass used to make the top of the tank or compartment is in proportion. The thickness of the square stock used allows the top edges of the tank to be filed off at an angle without any danger of filing through. This gives the tank a little more weight, but the accuracy by which the curve can be made by filing could hardly be duplicated by bending a piece of flat stock to this shape. The addition of the boxes at the front is accomplished by cutting and bending up pieces of sheet brass. Each piece forms a top, a front and an end. Cracks and openings are filled in with solder and then filed smooth.

The beading on the tender is made of brass wire. Solder one end in place and then straighten any kinks in the wire before soldering further. Bends or curves in the wire can be made when those points are reached.

The walks on the tank just above the center line are put on much in the same manner as the walks on the locomotive. The rear deck, which is made up of 1/32" x 1/8" brass stock, was laid out on a piece of paper and assembled upside down. This allowed soldering the lateral braces to the planking from the bottom. Always try to do soldering jobs from the inside or the bottom if possible. It saves cleaning up and makes a neater job. The lateral braces just mentioned were left long enough so that they could be bent down and fitted to the tank. Before these were actually soldered in place, the four doors on the top of the tank were made and soldered in place. The procedure for making these was the same as in making the sand dome on the loco.

Now to go about making the underframe details of the tender. Brass angle is used for the framework and two brass plates are soldered in place for mounting the trucks. The rear end sill or beam is fashioned out of square brass stock. Except for the addition of hand rails, trucks and a few pipes, the tender is complete. Incidentally, it is foolish

to spend the time making trucks and couplers. It can be done, but it is hard to make two of anything exactly alike.

Rectangular Tender.

The rectangular tank type tender is much easier to make. The sides and back end can be made out of one piece. The trouble is in getting the bends in the proper places so that the sides match up with each other. This difficulty can be avoided by making the sides and end separately. They can be reinforced at the corners with a piece of square brass stock which will allow the sharpness of the corners to be filed round.

The deck, of which the slope sheet is sometimes made a part, is soldered in place next. As this usually sits down below the top of the sides somewhat, a piece of wood of the proper thickness might well be used as a jig or depth gauge. To obtain the best results, lay the tender on the bench upside down. As the sides are usually higher ahead of the slope sheet, this portion should overhang the edge of the bench. Slip the block of wood down in between the sides so that it also rests on the bench. Then set the deck (upside down, of course) on the wood block. Holding the assembly firmly in place, run a fillet of solder around the inside. A thick block of wood nailed to the bench might help to prevent the sides from buckling while soldering the deck in place. In turning the assembly right side up, you should find that the deck is neatly soldered in place and evenly depressed due to the block of wood used for the purpose.

The front of the tender can also be built of thin brass sheet stock. The boxes usually found on each side of the coal gates or doors can be made by bending the front, top and side out of one piece, or they can be built up using separate pieces in their construction. As mentioned before, in soldering the beading in place start at one end and solder a short section at a time, doing whatever straightening or bending is needed as you go along. Perhaps a battery clip or a pair of pliers will help in holding the wire in place while soldering. It does get hot. One more point, solder the beading along the top edge only. It is easier to clean off and the crack naturally formed between the round wire and the flat side is taken care of at the same time.

Ladders, hand holds, etc., should, in most cases, be pressed through holes drilled in the tender body for the purpose and then soldered from the inside. The floor of the tender can be made from a flat piece of brass stock. Sides and ends can be bent down so that it looks like a shallow tray upside down. This piece should fit inside of the tender body. The side bends will look a good deal like the underframe of the tender, which usually can be seen just below the body.

Solder two plates to the bottom for mounting the trucks. The rear end sill can be made of a piece of brass stock and soldered in place, and the coupler pocket, which is fastened on a part of the end sill, can be made the same way as the locomotive coupler pocket. Steps are of wire soldered in place.

The link connecting the tender to the locomotive must be long enough to suit the sharpest curves on the layout.

Springing Locomotive Trucks.

It is usually desirable to employ some form of spiral springing on the lead truck of a locomotive owing to the fact that practically no weight beyond that of the truck itself is at disposal at this point. We have details for a trailing truck of a similar kind. The springs should not be too stiff, only the slightest pressure being required, but this must be definite and without impediment.

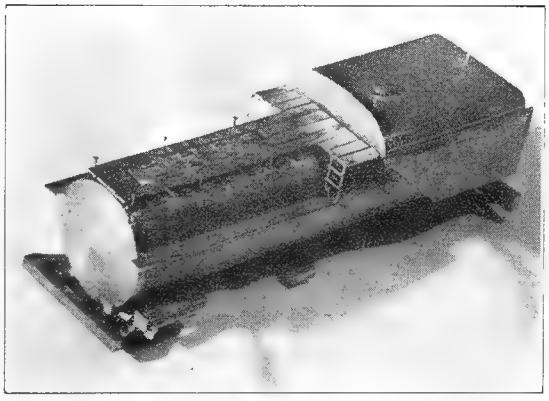
Piping Diagrams.

The external piping on a locomotive boiler and superstructure is a complicated item, and piping varies within limits on nearly every type of engine. But two charts will be of service in that they provide details of the general arrangement on a locomotive of fairly early vintage, about 30 years ago, and a modern example. A great deal of the finished effectiveness of a model depends upon the straightness and correctness of its piping. Incorrectly arranged piping will completely destroy the realism of the model.

Marker Lights.

Train markers, the flags and lights displayed on the front and rear of trains, have an important part in operation, and they affect locomotive design in that the sockets and brackets for the carrying of them should be fixed in place. The front end

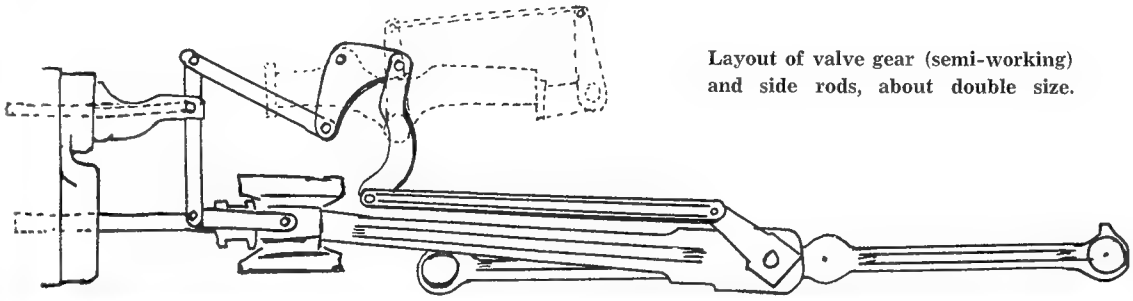
of a train on a regular run carries nothing by night beyond the headlight. But if a section is added to the train and follows it, markers to denote the fact go on the locomotives of all trains but the last sections. The markers for this purpose are green flags by day and green flags with green lights by night, as shown on page 65. A train not on the regular schedule is an extra, and carries white flags by day and white flags with white lights by night. Since an extra never runs in sections there is never any confusion. The lights show the color to the front and outside but nothing at the back and inside.



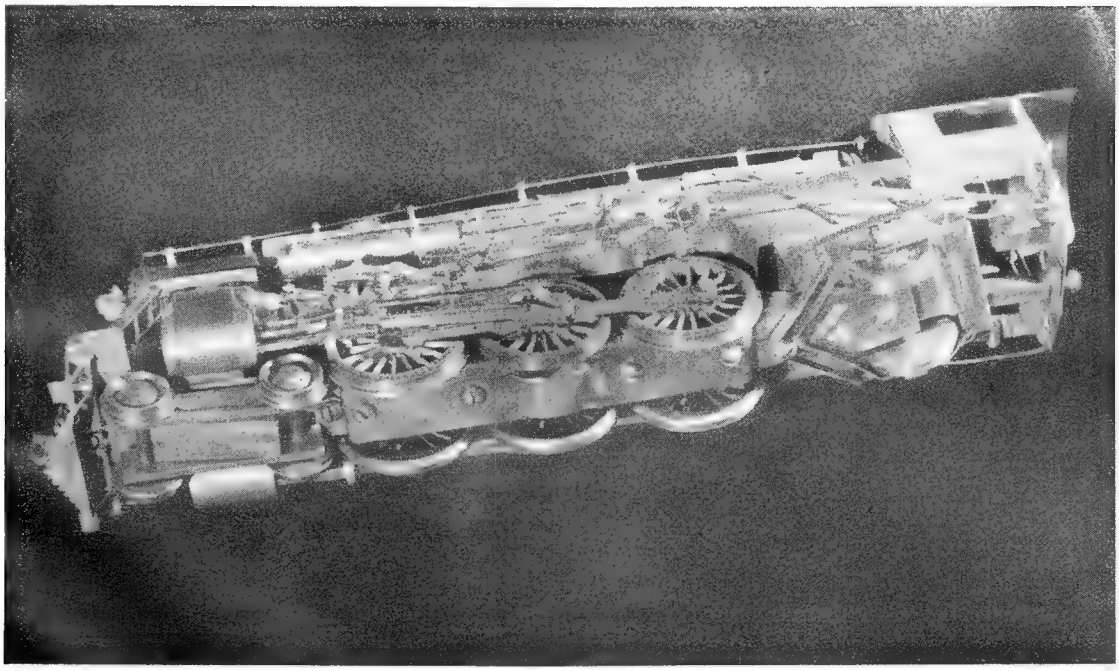
Three-quarters view of tank.

A train is not considered complete until its rear markers are in place. By day, the end of the train is marked with green flags at both sides, whether caboose or coach. By night, these flags are replaced with lanterns which show red to the rear and green to all other directions. When a train is on a siding these markers are turned with red to the inside and only the green is visible to other train crews. The sketch will furnish some hints on making and fitting marker lights.

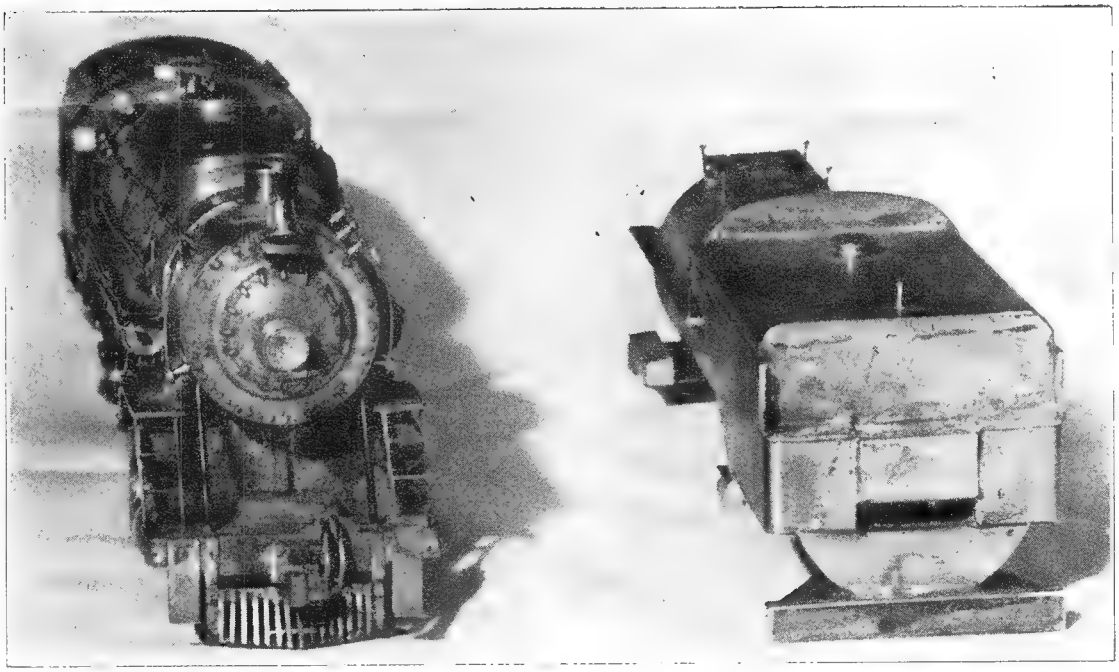
A further important detail is that of the



Layout of valve gear (semi-working) and side rods, about double size.



Bottom view of the finished locomotive.



Front view of finished locomotive with the tender body.

correct designing of the air hose connections between locomotives and cars, or between the cars themselves. This is illustrated in the accompanying sketch.

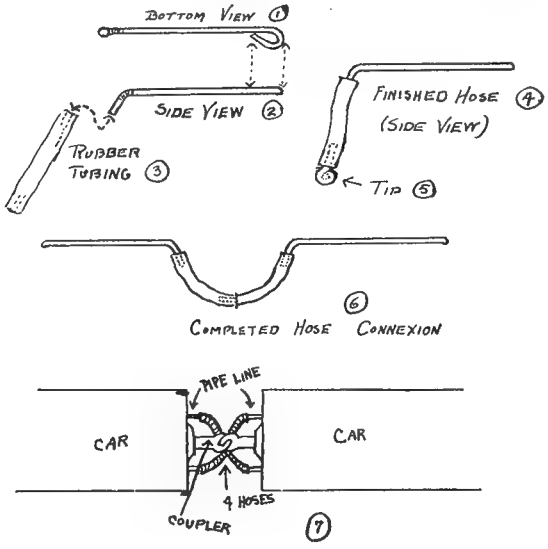
Air Hose.

A special design of truck is, as has already been stated, installed on Berkshire and Hudson tenders, which are unusually large and are therefore carried on 12 wheels. On one prototype there is a 16-wheel type, there being two trucks of eight wheels. The six-wheel trucks can be had commercially and are referred to in the section devoted to them.

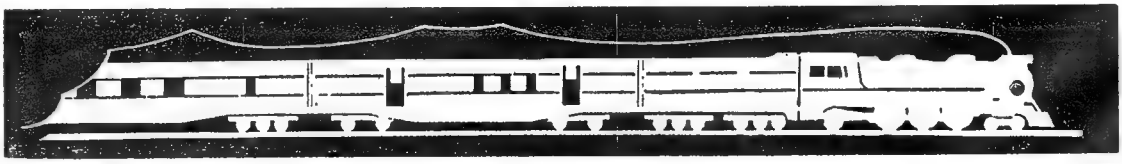
Designs for Tender Trucks.

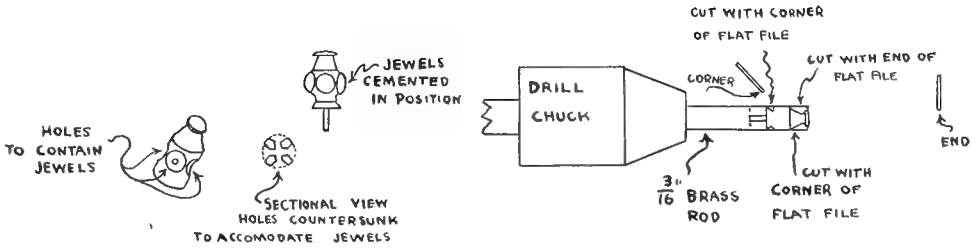
Strangely enough, one rarely sees a model with any attempt to reproduce correct scale cab fittings. Outside appearance seems to have thus far held the main attention of the manufacturers; probably they find it undesirable to have cause to raise the prices of their kits and models, and in most electrically driven units the mechanism projects into the cab too far to permit much space for this purpose. Yet it is a matter that is worthy of attention.

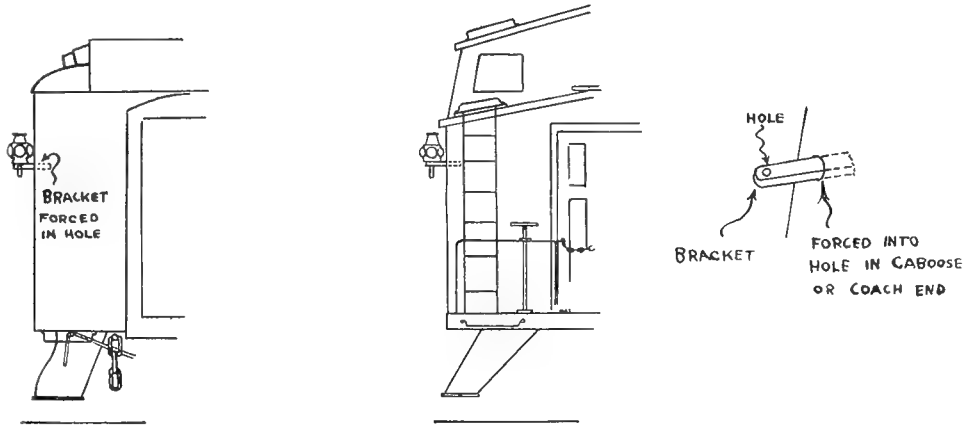
Cab Fittings.

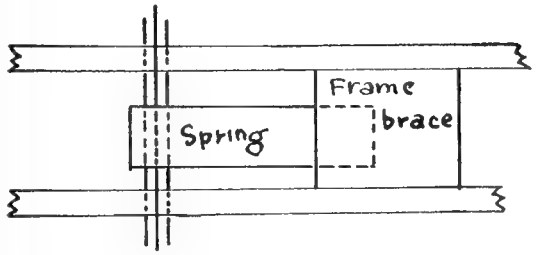


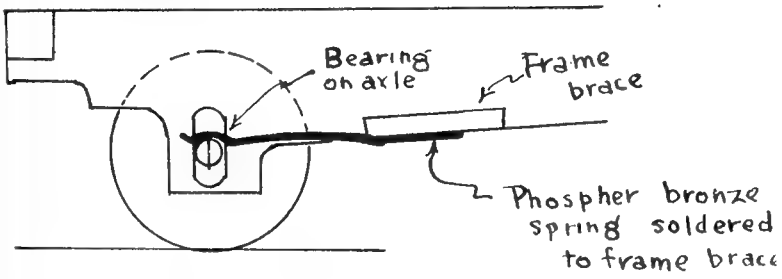
Double Hose Connection




HOLES TO CONTAIN JEWELS
JEWELS CEMENTED IN POSITION
SECTIONAL VIEW HOLES COUNTERSUNK TO ACCOMODATE JEWELS
DRILL CHUCK
CUT WITH CORNER OF FLAT FILE
CORNER
CUT WITH END OF FLAT FILE
END
3/16 BRASS ROD
CUT WITH CORNER OF FLAT FILE



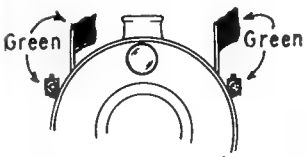


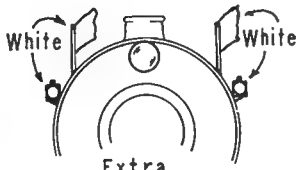


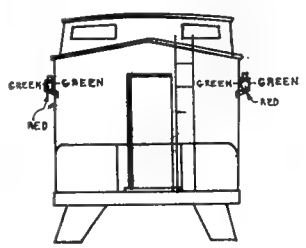
Above: Train marker practice.

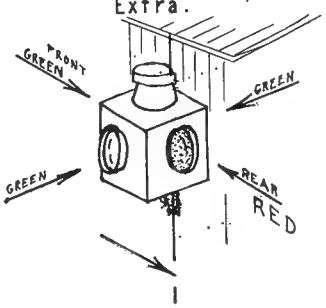
Left and below right: Spring support for leading and trailing trucks.

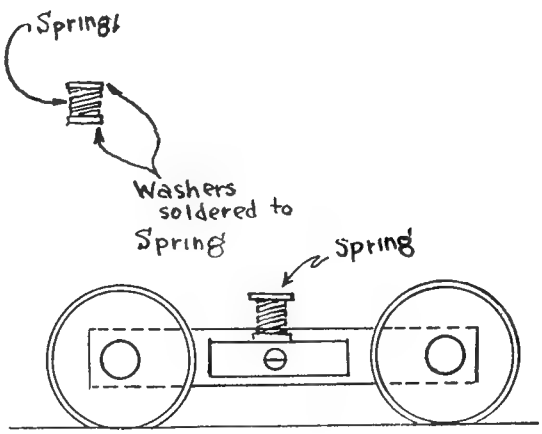
Left, below: Method of making and installing markers.

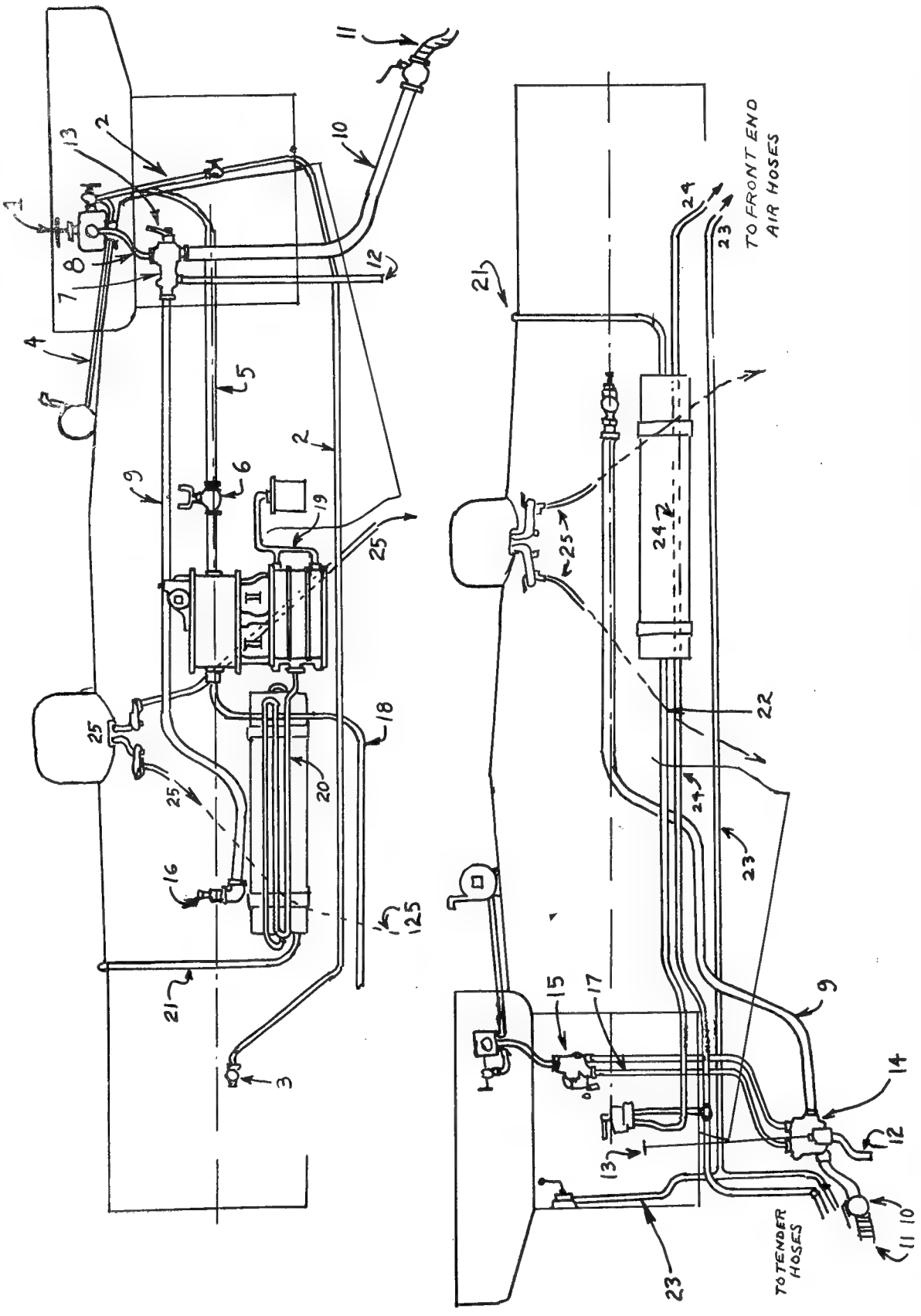










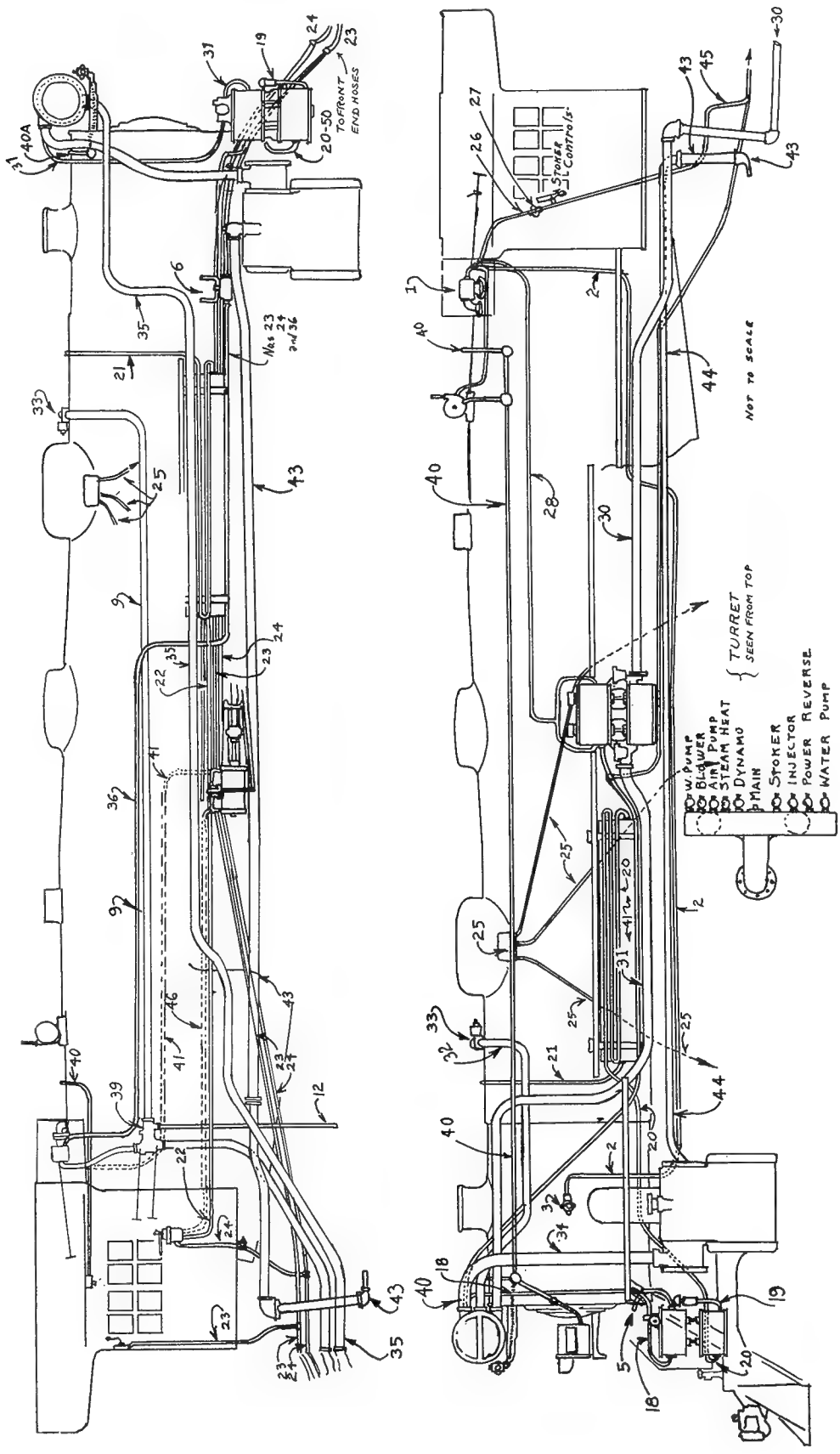

TO FRONT END AIR HOSES
TO TENDER HOSES

Typical Locomotive Piping

Key to Pipes Shown on Facing Page, Older Style Locomotive.

1. Turret.
2. Blower pipe, 2″ o.d.
3. Fitting for attaching outside blower to start fire.
4. Generator steam pipe, 1½″.
5. Air pump steam line, 2″.
6. Air pump steam governor.
7. Lifting type injector, may be in front of cab.
8. Injector steam pipe, 2½″.
9. Water delivery line, 3½″.
10. Suction pipe to tender, 4″.
11. Tender hose.
12. Overflow pipe, 1½″.
13. Injector operating levers.
14. Nonlifting type injector.
15. Injector operating valve.
16. Boiler check valve.
17. Steam pipes to nonlifting type injector, 1¼″ and 2″.
18. Steam exhaust from air pump.
19. Air intake, from strainer.
20. Air delivery line.
21. Connection between air reservoirs.
22. Air pipe to cab brake valves.
23. Air signal line, 1″.
24. Train line air pipe, 2″.
25. Sand pipes, 2″.

(All pipe notes are general and not intended to apply to any particular locomotive. Many locomotives are repiped differently at practically every shopping, so unless you have ample photos and data on the particular locomotive you are following, you will be safe in applying pipes sufficient for the needs of the particular locomotive and located about as shown.) (Prepared by John Leonard.)


20-50 TO FRONT END HOSES
No. 23 24 and 36
STOKER CONTROLS
NOT TO SCALE
TURRET SEEN FROM TOP
W. PUMP
BLOWER
AIR PUMP
STEAM HEAT
DYNAMO
MAIN
STOKER
INJECTOR
POWER REVERSE
WATER PUMP

Typical Locomotive Piping

Key to Additional Pipes Shown on Facing Page, More Modern Locomotive.

1. Note turret outside cab.
26. Steam heat line, 2″, only on passenger locos.
27. Steam heat valve.
28. Steam line for feedwater pump, 1″.
29. This number omitted.
30. Feedwater pipe from tender, 4½″.
31. Feedwater pipe from pump to heater.
32. Feedwater delivery pipe.
33. Boiler feed check valve.
34. Exhaust steam supply pipes for heater.
35. Condensed steam pipe to tender.
36. Steam supply to both air pumps.
37. Steam exhausts from air pump.
38. Air delivery pipe.
39. Injector; water pump takes place of other injector.
40. Electric wiring conduits.
41. Air reservoirs.
42. Number omitted.
43. Live steam supply for booster, 6″ or 7″.
44. Booster exhaust, 6″ or 7″.
45. Steam for stoker engine.
46. Air for power reverse gear, pipe under jacket.
47. Emergency steam supply for power reverse.
48. Condensate drain from steam line.

(All pipe notes are general and not intended to apply to any particular locomotive. Many locomotives are repiped differently at practically every shopping, so unless you have ample photos and data on the particular locomotive you are following, you will be safe in applying pipes sufficient for the needs of the particular locomotive and located about as shown.) (Prepared by John Leonard.)

5

Passenger Cars.

THERE are five or six branches in the classification of the passenger cars in service on American railroads. These include passenger cars proper, dining cars, combination cars, baggage cars, mail cars and certain types of service cars. Under the first head are gathered coaches, Pullmans, parlors, chair cars, lounge cars, sleeping cars, tourist cars and private cars; under the second we have dining, buffet, cafe, and dining-parlor cars; under the third section are the combination baggage, baggage and mail combination; under class four are baggage, express, horse cars, milk, and express refrigerator; under the fifth are postal, baggage and mail, postal storage, mail and smoker combination and combination baggage, mail and express; while in the service category are ranged those types of cars such as telegraph and electric-workers' cars, wrecking train cars, bunk cars, etc. It would be impossible to describe or to illustrate each type in any book of this nature, and there will be no such thing as a model layout on which every known type of passenger car is to be found. It is a matter of judicious selection. Yet very many of these cars have been modeled, and any of them might be chosen as prototype for a model system.

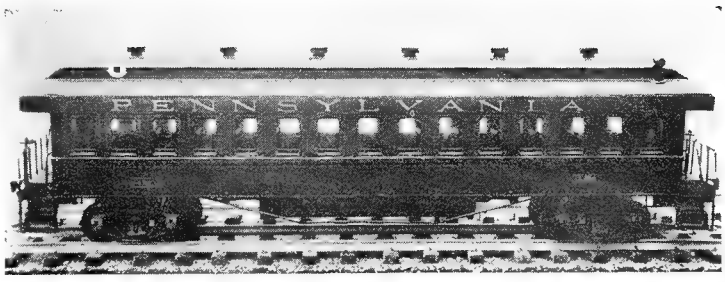
Types of Passenger Stock.

For the different gauges all manner of materials are used for building these car models; some are of metal throughout, some are of wood with aluminum or tinplate sides, some have celluloid sides, and many excellent examples have been formed from wood and cardboard. It is a good plan to restrict oneself to no special one of these methods, but rather to try them all and discover the one in which the individual worker can produce the best results. A popular method of construction, and indeed the earliest of all methods, was to form a stout frame of light wood, say pine, balsa or basswood, and then cut the sides from bristol board. Using this material one has the advantage of the easiest method of cutting out the windows and doors. Many of the commercial houses supply their coach sides in castings of thin aluminum, which is in every way admirable in that it so beautifully produces the necessary rivet heads, but which has the disastrous quality that it cannot be soldered, and it is extremely hard to tap. Turpentine is a good lubricant for this. Latterly, printed cardboard sides have been produced to perfection, and in some instances, by a photographic process, the prints are reproduced to show all the shading of the rivets and the window and door openings in a very convincing manner. Moreover, the difficulty of reproducing in exact verisimilitude the correct lettering is entirely overcome by this method when it is well carried out. Thin wood veneer is also used to excellent purpose by many builders. Recently, again, the method of superimposing one thin strip of material over another has been so adapted as to simplify the difficult task of securing protruding panels and beading.

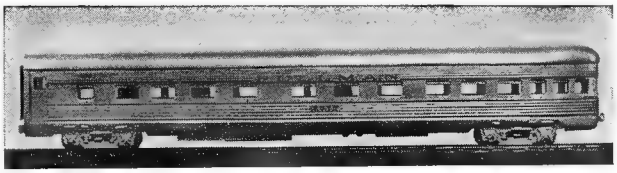
Car Modeling Materials.

There is a very splendid range of choice in passenger kits for all gauges and for ready built models in most. The question in choosing between two forms is somewhat different from that pertaining to locomo-

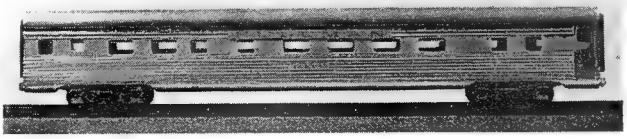
Finished Models versus Kits.



Old style coach—American Model RR. Co. O gauge.



Cars supplied by Pomona Valley Model Supply.



tives. For one thing, the finished examples are lower in price than engine models; for another thing, the kits are supplied generally in much more completed form with regard to cars. Again, the work of assembling the kit is far simpler than in the case of a locomotive kit. The whole job is more or less a matter of dining table work, and occupies less time. So that, on the whole, either procedure has its advantages; if it is a matter of cutting down costs the kit system is to be preferred; if time is scarce and cost no object the ready built model will be chosen.

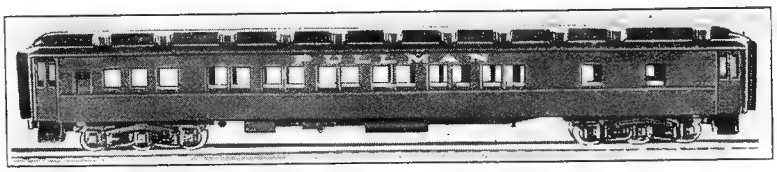
Numerous examples of completed lines are illustrated in the various photos. For

Market for Finished Cars.

O gauge the manufactured cars by Lobaugh, Walthers and Scale-Models, as well as those by Nason and other firms, can be highly recommended. Lobaugh offers units in two styles, those with sides of mounting board and lettered with transfers, and those with pressed metal sides and cast bronze ends lettered by hand, the latter being slightly higher in cost. Walthers cars have sides of punched brass, milled roofs and cast ends. Scale-Models examples are excellent with working doors and traps and die cast bodies; and first class $^{17}/_{64}$″ scale die cast cars are produced by Min-I-Scale. American Model Railroad Co. has a very fine model of an old time coach as a standard finished line, which is worthy of observation. This is shown in a photograph. For OO gauge there are types by Scale-Models and Nason, the former known as Scale-Craft Models. In HO gauge the supply is also plentiful. Walthers Taylor-Made cars are very good; Varney's Pullmans are excellent and quite original in their design and structure, and the Model Railroad Shop has a very acceptable line.

Building from Kits.

For O gauge and OO gauge the kits are normal and cover the ranges already enumerated. For HO gauge there are some departures. The Varney system of kit building has peculiarities of its own. This method is simple in the extreme, and the highly unusual way of producing the finely executed colored design directly onto the celluloid for the sides is to be highly praised. The small windows shine like crystal, the lettering is superb, and the entire surface of the sides is so permanently produced that it can be washed with soft soap and water. Walthers HO coaches (designed by Frank Taylor) leave nothing to be desired. They are standard full length; the roof walk is most meritoriously executed. The kits are very easy to put together. The small die cast fittings are sent out ready cleaned up, a very favorable feature. H. Owen kits are a fine

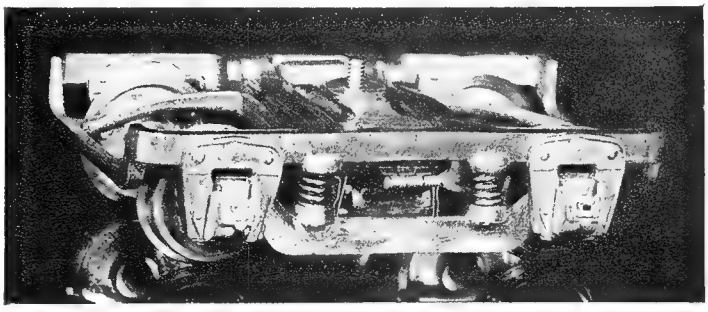


HO Pullman car by W. K. Walthers, Inc.

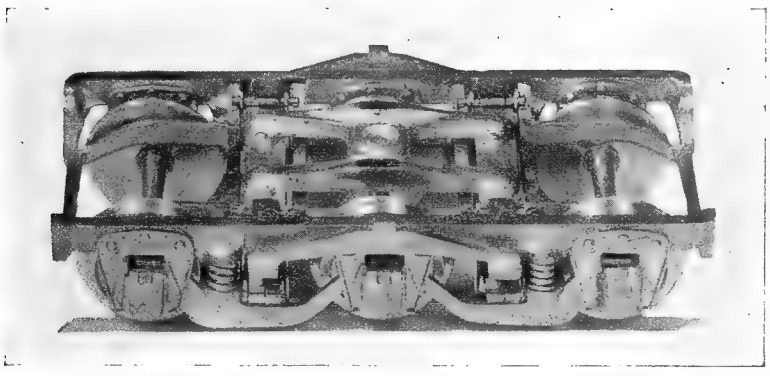
value for the money, the painting of the sides being left to the builder; transfer lettering is included. Hawk Model Co. has good wood side kits in O gauge which are inexpensive.

Car Parts. The range of parts is very complete, and most of the firms supply these as readily as the kits. There is such a complete range of parts for cars, especially in O gauge, that it is not possible to list them.

Passenger Trucks. Auel trucks must again be considered as the best detailed. Most of the firms supply these with their standard models at a slight extra charge. The scale of Auel trucks is, of course, 17/64", but this, for trucks, is no considerable difference whatever. The photographic illustrations of Auel's six-wheel Pullman truck and the four-wheel coach truck with their marvelous wealth of builtup detail, will speak for themselves. The Scale-Craft, Lobaugh and American Model RR. Co. trucks are all entirely commendable. Scale-Craft and Nason also supply OO gauge trucks of the four-wheel roller bearing and standard coach kind, and the former are very beautifully executed. Nason has some fine examples of six-wheel Pullman trucks in this scale, the sides of cast bronze, as well as the four-wheel standard type. In HO gauge there is a good supply; four-wheel and six-wheel Pullmans, four-wheel roller bearing trucks and many others may be had from Walthers, Varney, Stock, Lange, and kindred manufacturers.



Carl Auel passenger trucks.



Equalization. Many of these trucks are equalized, and this is a feature which should not be overlooked, for an equalized truck gives far more reliable running. Among firms whose O gauge lines are thus constructed are Auel, Lobaugh, and Scale-Models. Nason and Scale-Models OO trucks are so. Equalization consists, let it be said, of the swinging of the sides on pivots or screws with washers, so that when the bolster is held rigidly every one of the wheels has a floating up and down movement, and consequently every wheel is at all times on the surface of the track in spite of all ordinary track irregularities. This procedure is real practice and a very satisfactory way of assuring first rate running.

Insulation. Most of the firms now insulate their trucks for two-rail operation, though this is not quite universal. Nason trucks for OO gauge are equalized but not insulated unless specially ordered. Insulating, of course, is only a matter of bushing the wheels with fiber or bakelite to prevent operating current from passing from one rail to the other.

Interior Fittings. The interiors of passenger cars are seldom modeled in detail, and this offers one of the best opportunities for improvement. Coach seats are comparatively simple, and even complications of parlor and dining car interiors can be tackled with no expense but ingenuity.

Cars have been completely furnished even in HO gauge but the amount of work involved is often more than was required to build up the car itself. Balsa wood is very handy for interior work.

6

Freight Cars.

FREIGHT cars on a model layout have little value in themselves; any child, after all, may run a drag of freights 'round and 'round a circle. The real significance of a miniature freight train is only brought out by planning a system for freight traffic, and handling miniature, if imaginary, loads.

Miniature Freight Traffic. The layout should be considered from every standpoint that will contribute to realism of operation, and the handling of freight traffic is one of the most important factors to be provided for.

One happy scheme for the provision of freight destinations is to run off a single line branch, long enough to accommodate a train and with a loop on which the locomotive can be turned, to conceal it behind scenery, or a partition, a dummy wall or in a tunnel, and to take this as representing a branch freight line. If this cannot be done, or if additional facilities for freight are required, factories should be laid down at convenient points. An open gravel pit, a timber yard, an oil depot, or some other originating place of traffic can easily be arranged for, and will provide a place from which loads may be carried to their station destinations. With this system there is a real use for stated types of freight car on a layout.

Makeup of Freight Trains. Most amateurs aim at mixing their freight stock in order to have as many kinds of car as possible. Such trains are certainly colorful and interesting in their own peculiar way, but it may be just as interesting to run trains sometimes consisting of all one type of car. This is often done on real roads, and one attractive feature is that to build six or ten cars of one type in the shops is a much more convenient, expeditious and fascinating piece of work than to build one. A strawberry train consists of a solid string of reefers—a short, fast hotshot with a Pacific engine, running as fast as many a streamliner. Other kinds of solid reefer trains are drawn by Mountains or Hudsons.

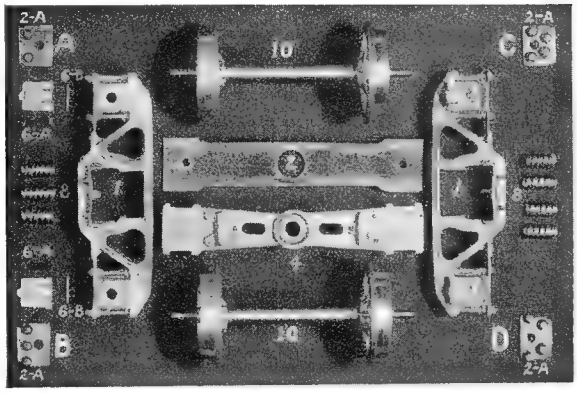
The tank car is a special type which we all like because it has plenty of detail in three dimensions. The solid tank train is merely all the reasons for the tank car multiplied by the number of cars in the train, and add one caboose. This is typical of certain regions and in other localities one may never see or hear of such a train.

Refrigerator cars often move together in red ball freights. Oranges from California and Florida, fruit from many orchards, lettuce from the truck gardening regions, dressed meat from the middle west packing houses start off in solid reefer trains. The bright yellow cars make fine models, and the variety of printed sides makes it easy to have plenty of attractive reefers. Special attractions are the fast disappearing private owner reefers—and what an attraction a solid train of colorful beer cars would make!

The milk train plays a big part in feeding our Eastern cities. There is a certain appeal about the older styling and the difference in lines and construction of most milk cars. Some are private owner types with unusual lettering and advertising matter.

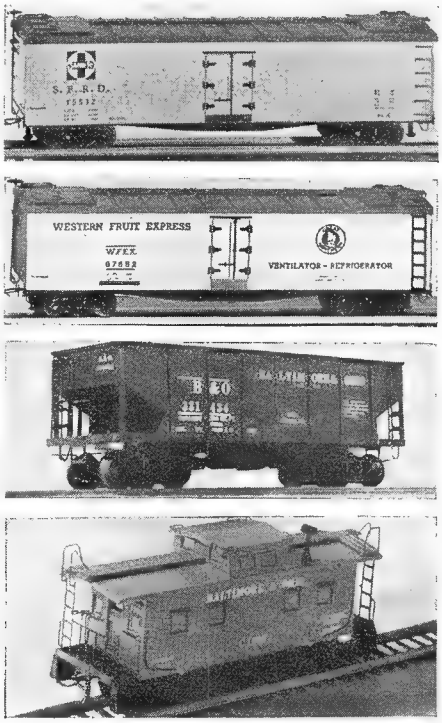
Heaviest trains in the country, even in the world, are the 10,000 ton or heavier ore trains eased down to the docks at Duluth from the iron mines 50 miles or so up and away from the lake. Favorable grade makes the immense

Scale-Models freight car and trucks (right).



Carl Auel's Andrews type trucks in unassembled form.

Below: Megow HO cars.



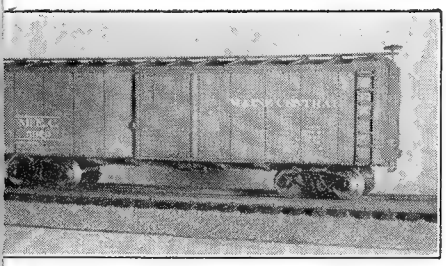
tonnage possible. Short, stubby cars in incredible number make the trains attractive to look at. For the model fan who likes long trains and big locos, here is a suitable solid train prototype.

The same goes for solid coal trains, as exemplified especially on the N&W, the C&O, and the Virginian. We could go on through still more types of solid trains, the lowly box car multiplied to 5000 tons, the flat car strung out into a train of many wheels and not much else, the train of new equipment fresh from the shops, and so on.

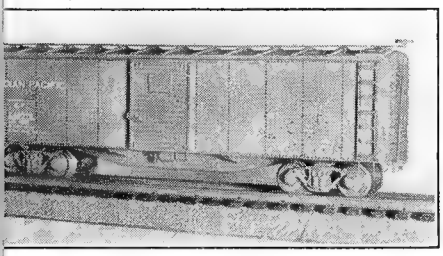
You know your favorite type of car. What would it look like by the trainload?

Freight Car Types.

There are so many differing types of freight cars in the country that to attempt to classify them here and now would be a waste of space as well as an almost inexhaustible task. The most familiar ones are the box car, the refrigerator, the gondola, the hopper, the flat, the stock car, the tank, refrigerators for passenger service. Each of these main classes is divisible into an enormous number of separate types. Thus, the box car (which outnumbers all other types by many thousands) includes the automobile car, the furniture, the combined auto and furniture, the insulated box, the tank box, produce cars and ventilated cars. Of hopper cars there are about 13 recognized and varied types, some with dumps between rails, others with side dumps, some wheel operated, some air-operated, some with two divisions for hoppers, some with four or six; some of doors separately controllable. Stock cars are sometimes built for cattle, sometimes for



Box car kit by Hawk of Chicago.



Hawk's Canadian Pacific box car kit.

O gauge Illinois Central reefer by Merle Faber.

horses, again for poultry, others have double decks for sheep and small stock. There is, indeed, no more fascinating branch of the railroad modeling craft than that which is devoted to this freight car construction and operating. Every railroad has its individual colorings, heralds and design. Tank cars especially are most fascinating, and privately owned refrigerators are always certain to be popular by reason of their colorful exterior finish.

Building Materials. Commercially, some freight cars are built of wood throughout, others of metal, others of a combination of the two. In the smaller models several firms produce box cars in solid body form, using a light basswood, which is excellent for the purpose, and of course dispenses with a lot of erecting work. These bodies are ready shaped to the requirements of the type, and all that is necessary is to cement the paper or cardboard printed sides, ends and roof, the printed sides often being very beautifully and realistically executed. Cardboard is not to be despised for the smaller sizes, either; yet the work required must be done carefully, using robust material, and be shellacked before painting in order to prevent warping. On the whole, for open cars of all kinds, the best materials to work with are metal or very thin wood. Brass is a good metal to work with and balsa wood is very easily worked with.

To freight cars we apply the same remarks that we made concerning passenger stock.

Built Up Models. The difference between the prices of finished units and kits is not very considerable; the kits are easily assembled on a dining table with very few tools, while on the other hand, with ready builts one is generally certain of obtaining excellence in lettering, a most important feature. Yet where the kits are provided with decalcomanias or transfers this trouble is largely overcome. Some very fine examples of O gauge builtup cars are illustrated in the photos. Lobaugh and American Model RR. Co. do excellent work, and so does Scale-Models. Min-I-Scale provides finished cars in the $1\frac{7}{64}$" scale, first class workmanship. Some excellent finished cars in O gauge can be had from Piedmont Southeastern Shops. OO gauge is again catered for by the two firms which mostly specialize in this scale. In the sphere of HO gauge there is such a glut of good material that it is difficult to enumerate all of the examples. Walthers offers a varied range to select from with no fewer than eight types of reefer, a couple of dozen box cars, and other kinds to tempt the buyer. Varney's range is also very full, and cabooses are supplied by Varney and Mantua. The Model Railroad Shop has its H. Owen range of finished cars which are highly satisfactory in every way, and which comprises well over a dozen designs. Lockhart-Laconia has some interesting selections

that include a number of private owner reefers.

The same firms provide kit outfits for all of the above types. For O gauge, these usually provide for wood construction unless on specially designed cars of steel. The construction proceeds in a standard manner, wood floor, sides and roofs with metal fittings and details. The Hawk Model Co. of Chicago, in its freight car kits with printed sides, provides a very satisfactory and inexpensive O gauge line for those builders who possess limited means for hobby purposes. The sides are die cut in cardboard, and are strengthened by pinewood strips and formers.

Kits.

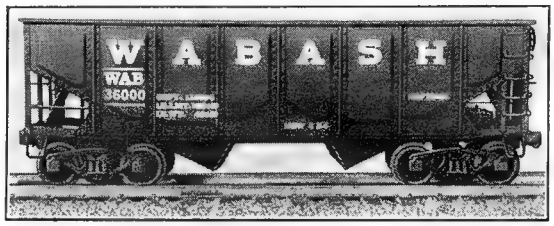
With HO cars there is some variety in the methods of constructing kits, and some of these we might briefly enlarge upon. A Varney box car is a straightforward job. The five main parts of the body are of thin wood which is smoothly and accurately cut to size. Strip is supplied for the catwalk on the roof and for the thin slats down the roof. Shaped wooden fishbellies are supplied for the underframe. Actual finished sides are on printed card and are in most instances photochrome reproductions in color of the sides of actual cars, showing all rivets and shading as well as detailed lettering, and very attractively done. The Varney gondola is a standard die cast plastic set of five parts which come ready to assemble. The underframe, a very good piece of work, must be cleaned up with a file. The stock car is an extremely good piece of die forming, most effective when built up. Ends are of pressed aluminum to represent corrugation. Varney flat cars are embossed in thin metal which is printed for coloring and lettering and then applied over a wood frame. The same process is also used for some outside frame box car types. Metal trucks and other details are included in these kits.

Varney System.

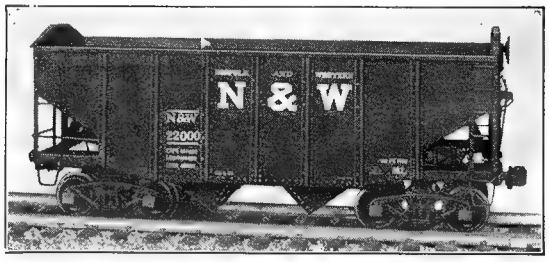
H. Owen kits, which were originated in the earliest HO gauge days by Eric LaNal and have latterly been considerably developed both in structure and range, may be had either as complete kits including hardware and undergear or simply as body kits. The latter include printed sides well lettered and colored and all the material for the walls, roofs, floors, as well as the metal body fittings. Kits include Andrews trucks. The tank car kits are unusually good and include the die cast metal underframe member, solid wood tank body with dome and a printed sheet for covering the tank.

H. Owen Cars.

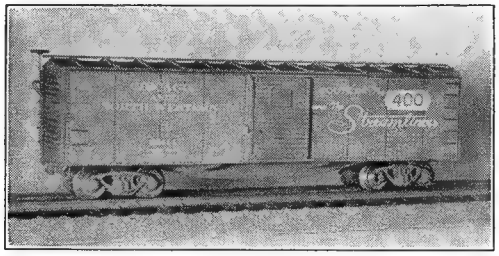
All-metal box and reefer cars for HO gauge are also manufactured by Mantua. Parts in these kits are already cut and filed correctly and there is no cutting, filing or soldering for the assembler to do. A special type wheel with trouble-proof insulation is included with these kits.



Above: Beeman's Wabash hopper car. Below: N&W hopper by Beeman. Both are O gauge.

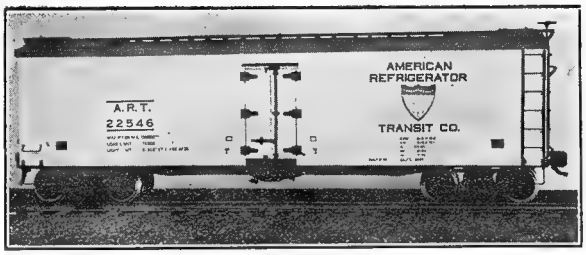


Below: Another Hawk box car kit.

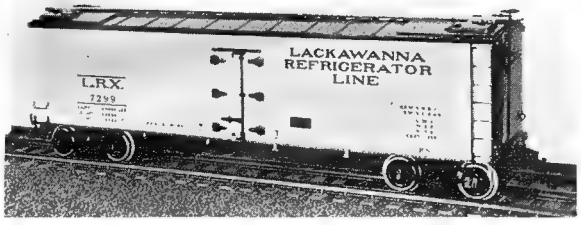


Walthers' Taylor-Made house car kits are entirely different in that they include for box cars a solid body in basswood on which the printed and embossed sides are cemented when the model is built up. These kits make very fine models, and other types of cars are provided for according to their special design.

Taylor-Made Kits.



O gauge Westbrook cars have a long-time reputation for sharp authenticity.

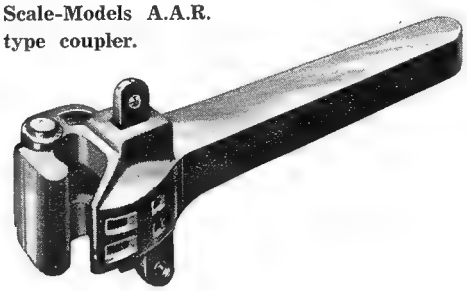


Below, Model RR. Shop (Dunellen) reefer.

Individual Parts for Cars—Freight Cars.

For those who wish to do most of the constructional work for themselves there is no lack of materials to select from. The range of O gauge freight car parts by Lobaugh, Walthers, Scale-Models, American Model Railroad Co., and other firms is enormous and complete in every particular. And the same remark applies practically to HO gauge parts, as well as to OO. For HO, Mantua, Stock, Varney, Lange and other catalogs should be consulted. Walthers supplies

Scale-Models A.A.R. type coupler.

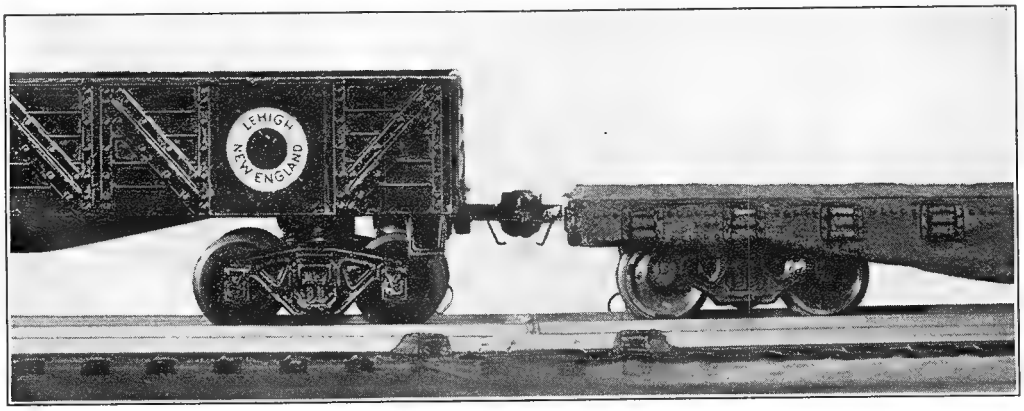


freight cars with embossed features for HO gauge in printed card form which incorporate all necessary lettering.

Freight Trucks.

Freight trucks for each gauge can be procured from the respective dealers. Auel has magnificent Andrews type trucks that are faithful to the tradition of his handiwork. Lobaugh has an almost complete series to choose from. Wheels supplied by all the recognized firms, by the way, whether freight or passenger stock, conform to N. M. R. A. standards. From Lobaugh may be obtained a six-wheel Buckeye freight truck, and for ⅞″ gauge the standard truck is of Andrews design made by Cleveland, a very tidy die casting. Nason OO gauge trucks for freight are Dalman, and Scale-Models has the roller bearing type. For HO gauge almost every design may be had excepting the Buckeye. Again consult the various manufacturers catalogs.

There are several accurately working O

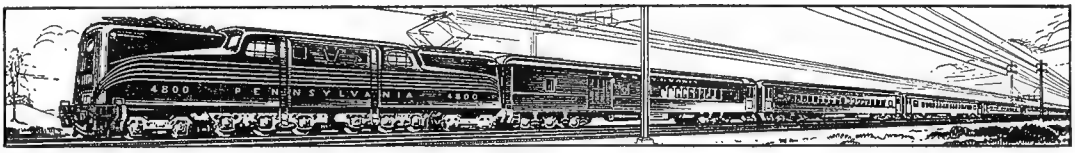


The K&W HO Automatic Coupler.

gauge couplers on the lists, Scale-Craft, Pat Sweeney and Monarch. Dummy couplers are most popular, most operators being content with manually linking the couplers, or vice versa, by simply raising one of the cars. Only ¼″ lift is needed for this purpose, and this does not involve moving the wheels from the rails. The best dummy coupler is made by Carl Auel. For HO, Walthers has scale couplers of the dummy type.

Commercial Couplers.

There are also three non-scale automatic HO couplers on the market, and each one is well authenticated and fairly reliable. The Varney auto-coupler and uncoupler comes in the rough and does what is demanded of it. The La Nal coupler is also well tried both in America and (regarding its British brother) in Britain. It is almost 100 per cent effective. Recently the writer has been experimenting with it and has designed an improvement which entirely dispenses with the visible V of the shank by concealing it behind the wheels. This can be quite easily done by bringing the V further back along the shank and shaping the shank so that it fits on or near to the truck pivot, underneath the bolster. The Mantua also has a sound reputation and is widely used. The new K&W coupler is the most realistic of HO couplers of the automatic type. From the side it can hardly be detected from the A. A. R. standard type coupler. An illustration showing the K&W coupler in use is on the preceding page along with Scale-Models A. A. R. coupler.



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Constructing Rolling Stock.

THE diagrams on the next two pages give dimensions for modeling coaches. It should be noted that there is really no fixed and absolute definition for these standards; different types of car vary in their sizes within certain limits, and these are indicated in the drawings. The drawings themselves are for a standard Pullman, while the printed dimensions indicate the range of liberty allowed on coaches other than Pullmans. The figures that are underlined are for sizes that must not vary. The measurements given are for medium common practice, and when in doubt the builder should use either Pullman or the common dimensions. With regard to the window widths, only a few prevailing dimensions are given, and the length of the cars must be ascertained from the drawings of the type to be modeled. These details should be of a sufficient nature as to meet the requirements of those who need general proportions; for work on special coaches it is suggested that the builder should secure drawings of the type to be modeled and scale these off to the required size as already described.

Designs for Passenger Cars.

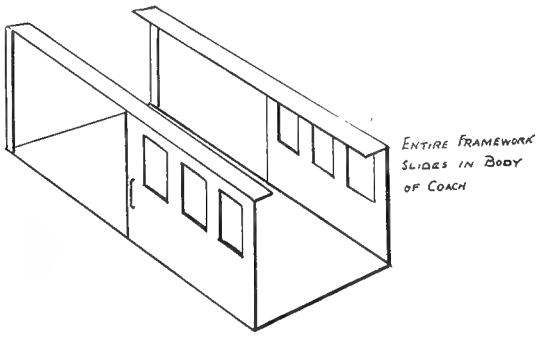
For detailed plans of passenger cars the reader is referred to the Model Railroader Cyclopedia, to various issues of The Model Railroader and to other publications in the field. Plans are available for practically every type of car in these sources. It will be seen that each of these types has its own peculiarities, this being noticeable, for instance, in the distancing of the truck centers. On two of the vehicles these are set well out towards the car ends, when the presence of stairways does not necessitate the placing of the trucks so as to avoid these obstructions, though there is another instance in the Santa Fe in which the trucks are placed further in than is the usual case.

Building a Passenger Car.

The method of procedure on a standard car is to start by cutting basswood or other light timber pieces for the floor, ends and roof. For the roof, correctly molded strip may be had, or this may be trimmed from ordinary strip to form the side curvature, this being carried out before the roof is fixed. The longitudinal shape also of the upper roof sections should be finished with file and sandpaper before fixing. It will be found, with due care, that shaping this rather tricky part of the work is not very difficult; it will take the proper shape naturally if correctly handled. Shape the end first, then the roof. The fitting together of these sections is done with pins and regular model-makers' cement.

Underframe.

The underframe work is built up in wood strip cut to the necessary shape and having a cardboard capping fixed underneath. It should be noted that the undergirders begin close up to the truck pins, as close as can be arranged without fouling the movement of the trucks. It is good to get detail work under the car done before beginning to work on the finished sides. Steps, or stairways, can be obtained so cheaply and are so well produced that for the smallest gauges they are not worth the time and labor which would be expended in the making of them. The same applies to nearly all the detail work of a car.



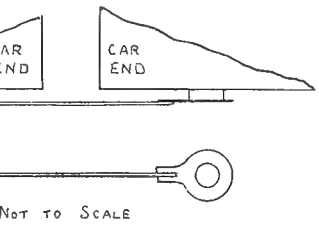
Sliding Baggage Doors

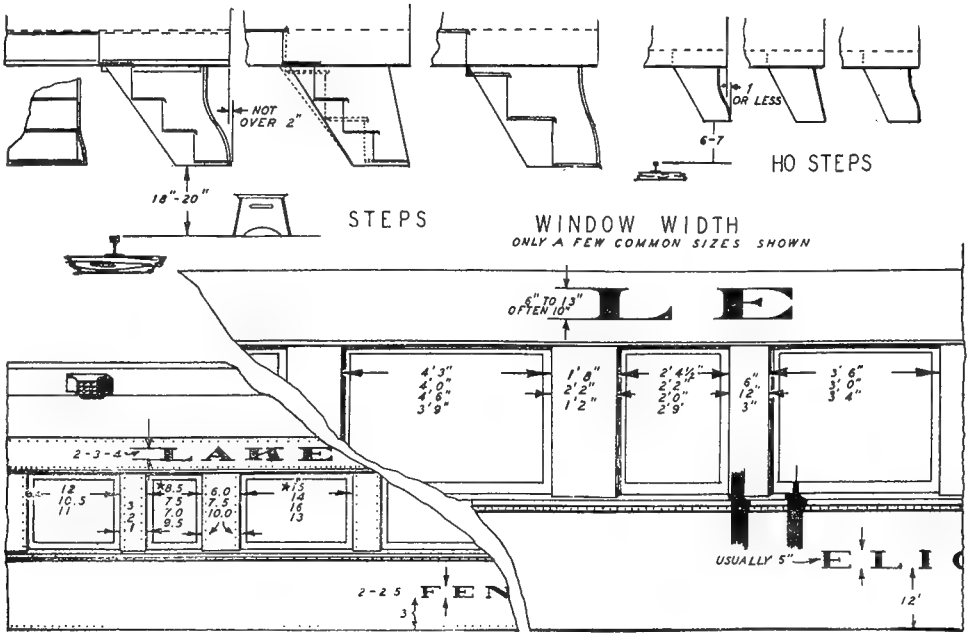
It is no very difficult task to make the doors of baggage cars, even in the smallest scales, so they slide open.

Sliding Doors for Baggage Cars. Many of the firms supplying kits provide for this small refinement, notably Scale-Models. A simple way is given above whereby this can be done.

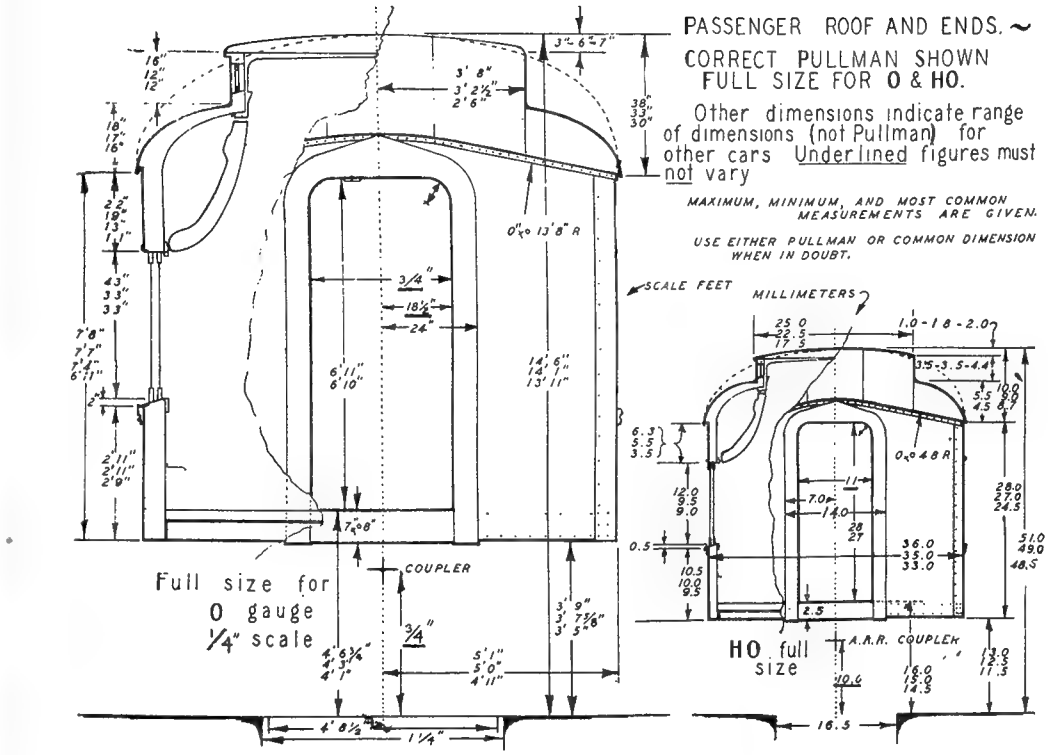
Here is a decidedly simple and positive scheme for permanently linking up passenger coaches, and one which gives absolutely infallible running service. It has been tried thoroughly for over a year on the author's layout where several such trains are run, and he has discarded all other methods in favor of it. The fact is that the splitting up of trains into separate cars is very rarely necessary for passenger service. Once the cars are in series they tend to remain so, especially if storage sidings for coaches are sufficient (as they ought to be) to take an entire train without breaking it up into units for storing. Occasionally it is true that an extra coach needs to be added; it may even be possible to double the length of short permanent trains. The arrangement of the simple couplers, which merely consist of a length of wire with a flap of very thin phosphor bronze at each end to go under the truck screw hole, applies only to the inside ends of the cars. The two ends of the train will have the common standard coupling used on the railroad. One or two extra cars can be kept with each end provided with the common coupler, so that they may be added or removed from the train at will. It is important to use thin material for the flaps, in order not to raise

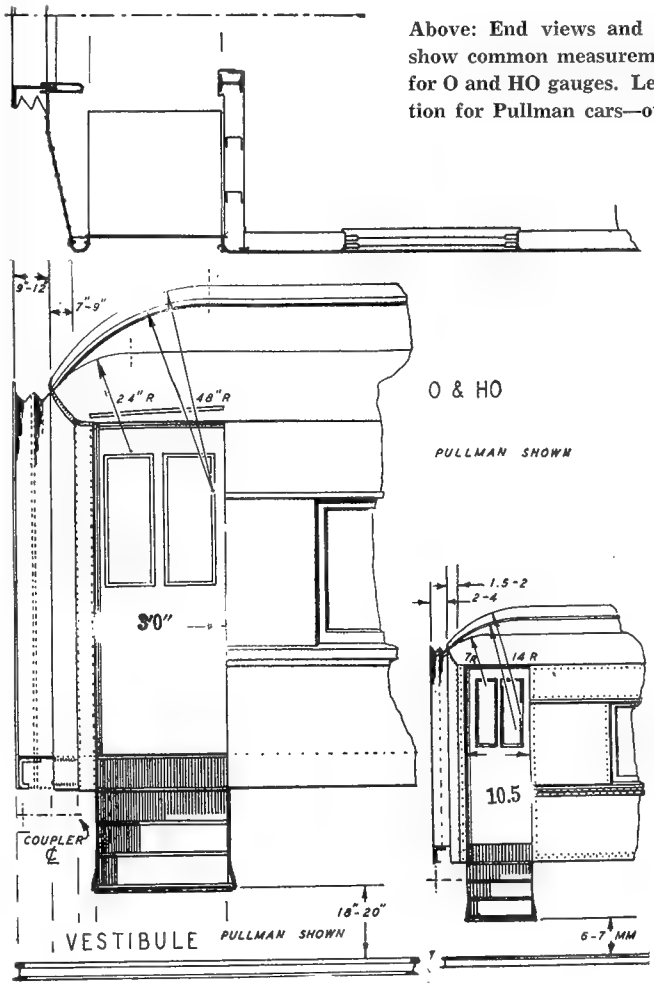
Coupling Passenger Trains Permanently.





Top sketch shows HO and O gauge step shapes and sizes for typical passenger cars. Bottom sketch shows common window sizes and lettering heights.


PASSENGER ROOF AND ENDS. ~
CORRECT PULLMAN SHOWN
FULL SIZE FOR O & HO.
Other dimensions indicate range of dimensions (not Pullman) for other cars Underlined figures must not vary
MAXIMUM, MINIMUM, AND MOST COMMON MEASUREMENTS ARE GIVEN.
USE EITHER PULLMAN OR COMMON DIMENSION WHEN IN DOUBT.
SCALE FEET
MILLIMETERS
Full size for O gauge ¼" scale
COUPLER
HO full size
A.A.R. COUPLER



Above: End views and sections of Pullman cars. The figures show common measurements for other passenger cars. Full size for O and HO gauges. Left and below: Vestibule plan and elevation for Pullman cars—other cars are very similar to this.

unduly the height of the cars above the rail and thus interfere with the coupler heights as well as the general appearance.

Modeling Freight Cars.

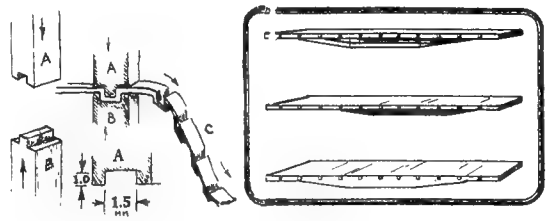
Freight cars may be said to differ from both passenger cars and locomotives in that they are so diversified in their design. Hoppers, box cars, gondolas, flats and tanks are so different as to require a separate description for each type of structure. In the plate (page 79) will be found an excellent dimensioned drawing, full size O gauge, on which every item in the equipment of a standard steel frame railroad box car is shown and named. From the actual size of this drawing all other scales may be reckoned, although sizes, of course, will vary with nearly every type of car in service. Some of these are shown in the diagram for box cars on the next page. Plans for a great many cars

are available in the issues of The Model Railroader, The Model Railroader Cyclopedia, and in other model publications.

Building a Box Car.

There are many methods in common use for building box cars but most of these make use of thin wood sides and ends upon which metal doors, ladders, brake platforms and other fittings are fastened by using small pins. The wood sides are usually cut across the grain to allow scribing to represent cracks between individual boards when a wood sheathed car is built. Roofs are made from special wood molding with various fittings when required. Most details and fittings can be had so reasonably that it would not pay to fashion your own.

Many car sides are available printed on cardboard. These are particularly useful for refrigerator cars where a great amount of lettering has to be done on a light colored background. These sides are best mounted on the surface of a wood sheet and sawed to shape. They should be assembled to the car after all other parts to avoid soiling. If one desires to avoid the use of printed sides, complete sets of transfer lettering can be had from Walthers or the Model Railroad Shop, and fittings can be bought almost anywhere. The solid body method of box car



At left: Method of making stake pockets. At right: Sketch of three types of flat car.

building for HO gauge has a lot to recommend it; but whatever the method of body building used, there are numerous details which can be well elucidated by consulting the constructional details in the chart issued by Walthers. Walthers also has a book on the construction of passenger cars which is very helpful. Small detail parts can be had commercially.

COMMON LENGTHS OVER COUPLERS

PASSENGER

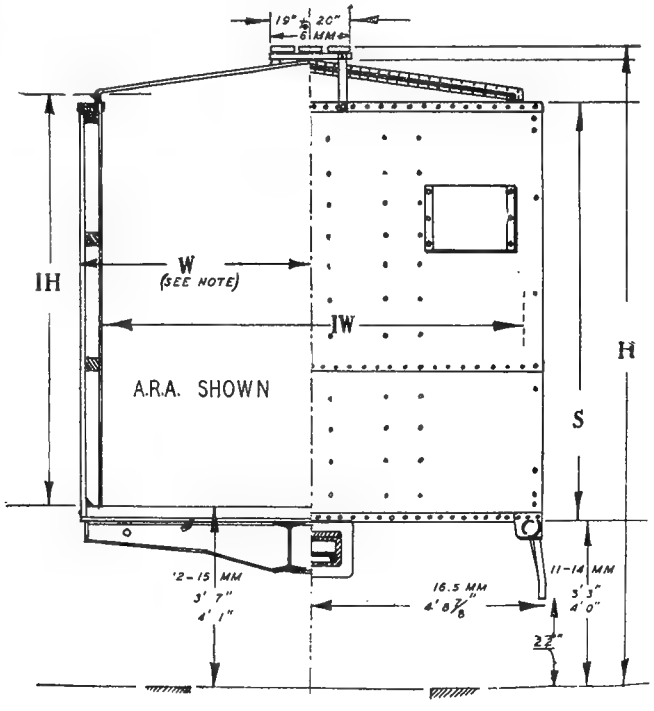
FEET
65
68
73
79
80
83
85

NOTE: A CAR IS CLASSED BY DISTANCE OVER BODY ONLY. VESTIBULES ADD UP TO TEN MORE FEET. THUS A "SIXTY-FOOT" CAR IS 86 TO 70 FEET OVER COUPLERS.

FREIGHT

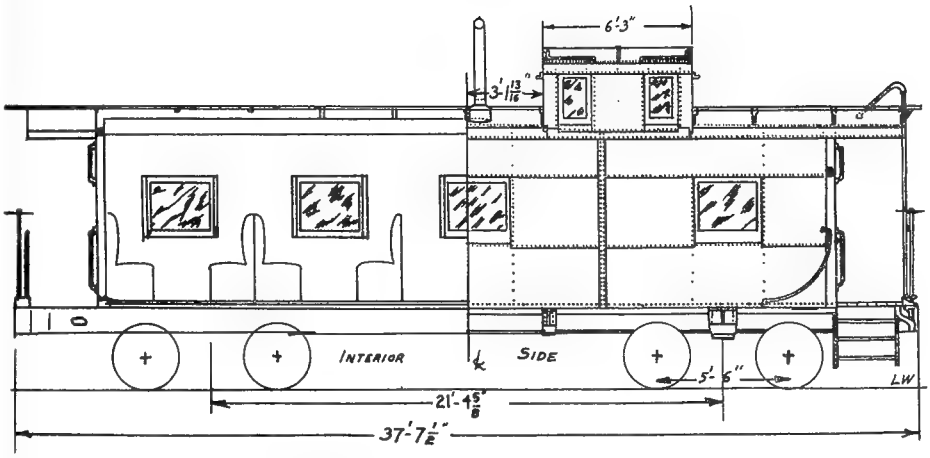
LENGTH	BOX	REFR	STCK	FLT	GON	HOP	TNK	HO MM
FEET								
24						●		84
33						●		116½
35							●	122½
36		●				●		
37						ARA	●	
38	●			●			●	
39	●	●	●					
40		●				●		140
41			●					
42						●	●	
43	●	●		●	●	ARA		
44	ARA	●	●	●	●			
45		●		●	●	●	●	157½
46					●			
47				●	●			
48				●				
49				●		●		
50					●	●		175
51								
52				●	●			
53	●				●			
54	●			●	●			
55								192½
56				●				
58						●		
63					●			
67					●			
70					●			245

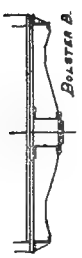
Above: Table of common lengths for freight and passenger rolling stock.

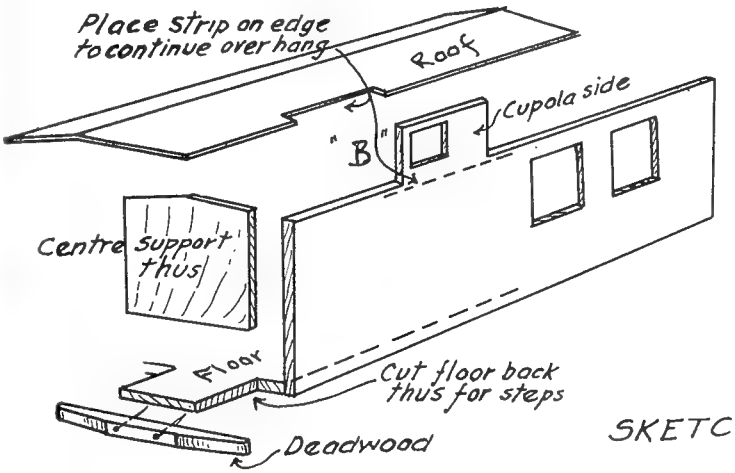


Left: A. A. R. box car end plan to ¼" scale.

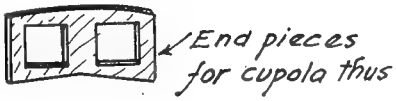
Note: Dimensions for IW, IH, etc., can often be taken from the lettering on the outside of the car. With proper allowances it is possible to obtain a reasonably accurate figure for other dimensions when plans are not available.

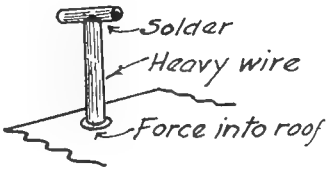




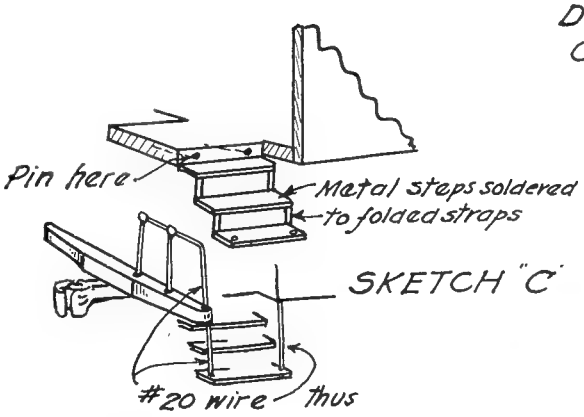


SKETCH "A"

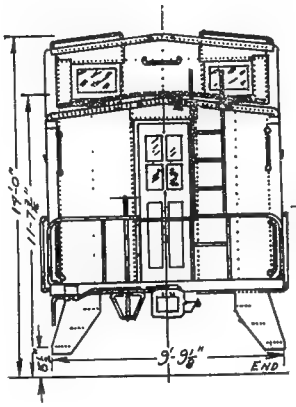


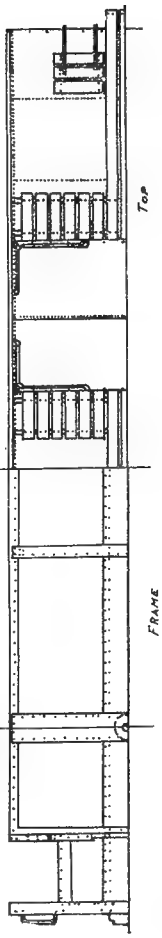


DETAIL OF CHIMNEY

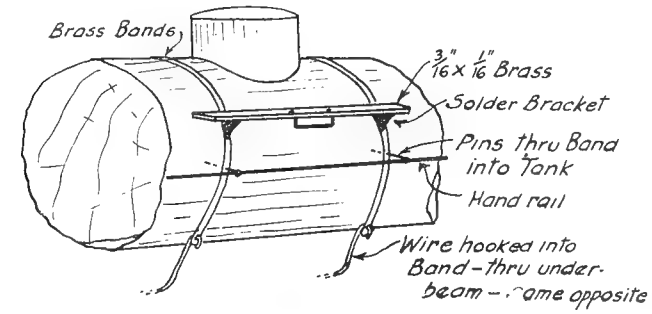


SKETCH "C"

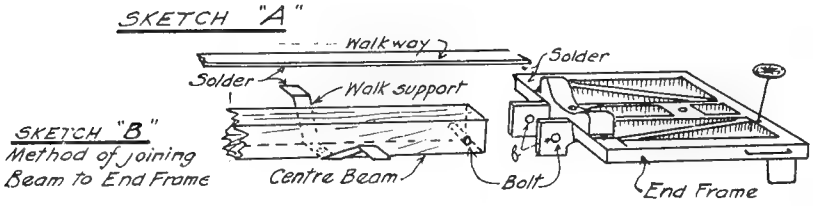


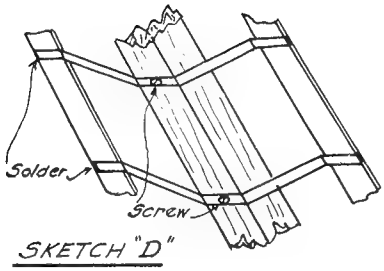


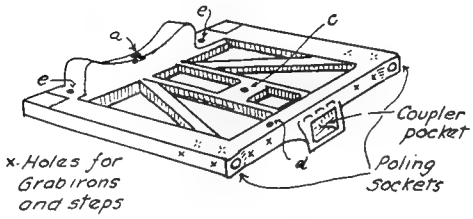
Shown on this page are plans and sketches for the construction of a caboose. The prototype is CMStP&P. Caboose plans are to ⅛" scale.


Brass Bands
3/16 x 1/16 Brass
Solder Bracket
Pins thru Band into Tank
Hand rail
Wire hooked into Band - thru under-beam - ame opposite

Details for building tank cars.







Most flats have stake pockets on the side sills to receive posts, and these can be made by scribing squares on a sheet of cardboard, cutting out the pieces and bending them on the creases.

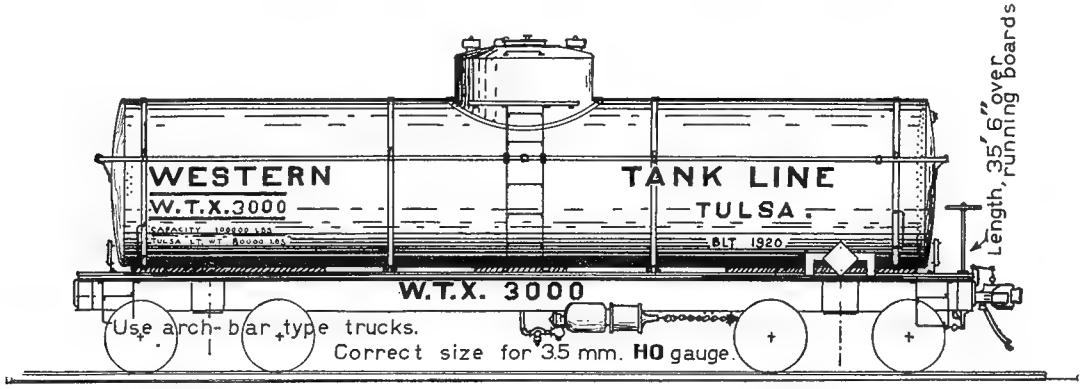
For caboose work, consult the caboose designs and sketches on page 83. The latter afford guidance on all the important parts of the work peculiar to this type of car, the cutting and fitting together of the roof, the shaping of the sides, the recessing of the floor for the step, the center support, and the making of the steps. The caboose should be especially well built, as this piece of rolling stock always gets the last long glance from visitors when your train goes past them.

Tank cars are unique in their design. Most

Flat cars are actually of three types; those braced with rods, those with central fishbelly bracing, and those with bracing of the same kind on the outside. The drawing (page 82) shows all three types. There are really few departures from the box car job for a wood type of structure in O gauge, or for that matter in HO.

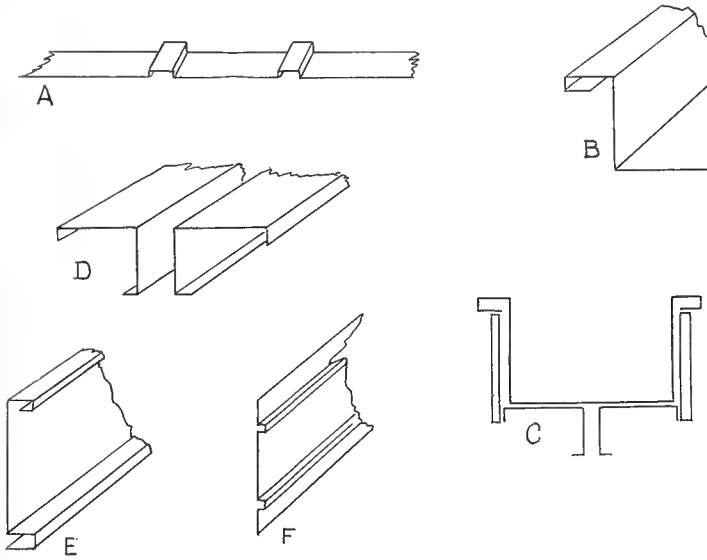
Flat Car.

Cabooses.



of them have no floors above the metal frame forming the underbody. These metal frames can be had from most firms ready cast for 25 cents each, and the tank blocks for a few cents. Some aid may be had from a combination of the sketches on page 84. Amongst other details these show the securing of the sidewalk supports to the underframe, and the fitting of the upper walk strips. The build-up of a wood underframe is really not worth the trouble.

Tank Cars.



METAL GONDOLA WORK

We now come to the details of hopper cars. There are several methods of working up the hoppers. One firm supplies an excellent cast underframe complete, with hopper included, for HO gauge. Another provides solid blocks of wood to represent these. The H. Owen method is a solid balsa block for the entire body.

Hopper Cars.

Undoubtedly for flats and gondolas the best method of construction is that of using metal throughout. This produces a much more sturdy job and it can be applied to any scale. A good scheme is to make the floor out of 18 gauge flat brass for O gauge, 20 gauge brass for smaller scale types. Carefully square the ends and the sides, making them perfectly even by rubbing the edges along an old file. It is an excellent plan, also, to have on hand for car construction a sheet of plate glass with the edges ground smooth which can be laid on the bench and used as a surface plate, so as to get everything absolutely flat and rigid in the work; a piece about 12″ square will do. Most flat cars have a semi-circular piece cut out at one end of the floor into which the brake wheel can be sunk to get it flush with the floor and out of the way. It can be filed out for the model with a rat tail file. The marks representing the planking can be scribed with a square and a scriber, making rather deep ruts so that the paint will not fill them in. The side sills, where these appear, can be made with 1/16″ brass strip, and are sweated on the ends. Center sills may be cut from thin brass sheeting by use of a template of cardboard so as to get them all the same size. Do not leave out the cross braces of the underframe. The stake pockets are of shim brass, less than .008″ thick. They may be shaped by the dozen, all alike, by using a die. One section of the die is screwed into the vise, the other used as a punch. The poling pockets can be made by using a twist drill, giving it only a few turns.

All-Metal Construction.

O gauge gondolas can be made on the all-metal principle also by using tinplate. To begin with cut strips of tinplate to the height of the gondola sides and slightly longer. Then raise the ribs on these sides by using a simple die (sketch A). Next make a lining, which is nothing more than a channel with a lip along each upper edge (B). These three are then soldered together to form a section. The underframe is in two pieces (D) which are soldered in place to make the entire section as in C. Ends are each built up of two pieces (E and F).

Gondolas.

8

Special Rolling Stock.

UNDER the heading of this chapter it may be well to gather together those types of vehicles which are scarcely classifiable under the earlier sections. These may be considered as including service cars, such cars and trains as are commonly devoted to the transportation of special loads, and wrecking cranes.

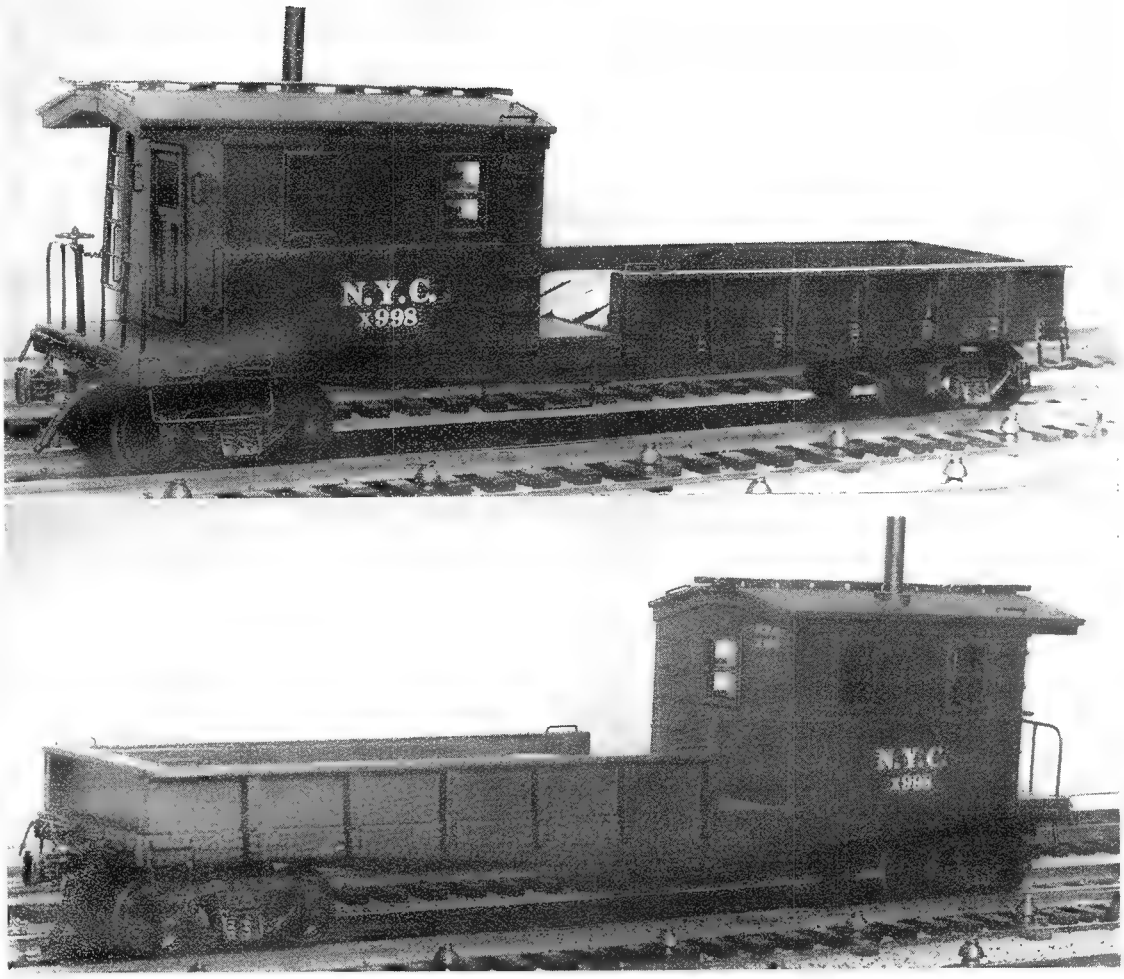
Building a Work Train.

No matter where you travel on a railroad you will see somewhere along the line a string of work cars, and you will feel that this type of train would be a most interesting addition to your layout. The work train itself may be devoted to some special trackside activity such as right of way work, overhead catenary survey, bridge engineer's department, or may form a part of a wrecking train. In the majority of instances the cars comprising these trains are rebuilds from old box or house cars; and on a model layout it is often possible to salvage a pair of trucks and set of safety appliances from such a car even if the body of it is beyond value; or, maybe a broken car can be pressed entirely into use. The design for such a rebuild shown on page 87 comes under this category. If the body requires it, scribe the sides and ends vertically to represent planking. Lay out and cut the window and door openings in the sides; they may be cut with a sharp knife or razor. Door portals are also cut in the car ends, the dimensions given being for O gauge. Window sashes and trimmings for the doors can be cut from card strip, and should overlap the openings about 3/32". The doors also are of cardboard. Cellophane windows and the doors are glued on from the inside. If a body is being built, it should be assembled with pins and cement in the usual manner. Before driving home the pins, the heads should be snipped off so that they do not show after fixing. Holes for the hand grabs and steps can be made in the wood by gripping a needle in the end of a vise jaw and forcing it into the wood. The trucks for work cars should usually be arch bar, though this is not essential. This type was common on the kind of cars that are rebuilt for this service. The sash bars of the windows and the window frames should project well from the sides of the car, giving the appearance of having been superadded.

On page 88 will be found a number of such cars as would go to make up a train, in this instance a wrecking train. These comprise a mess car or bunk car (both alike), a kitchen car, a foreman's and commissary car and a wrecking crane auxiliary car. The latter will be referred to later.

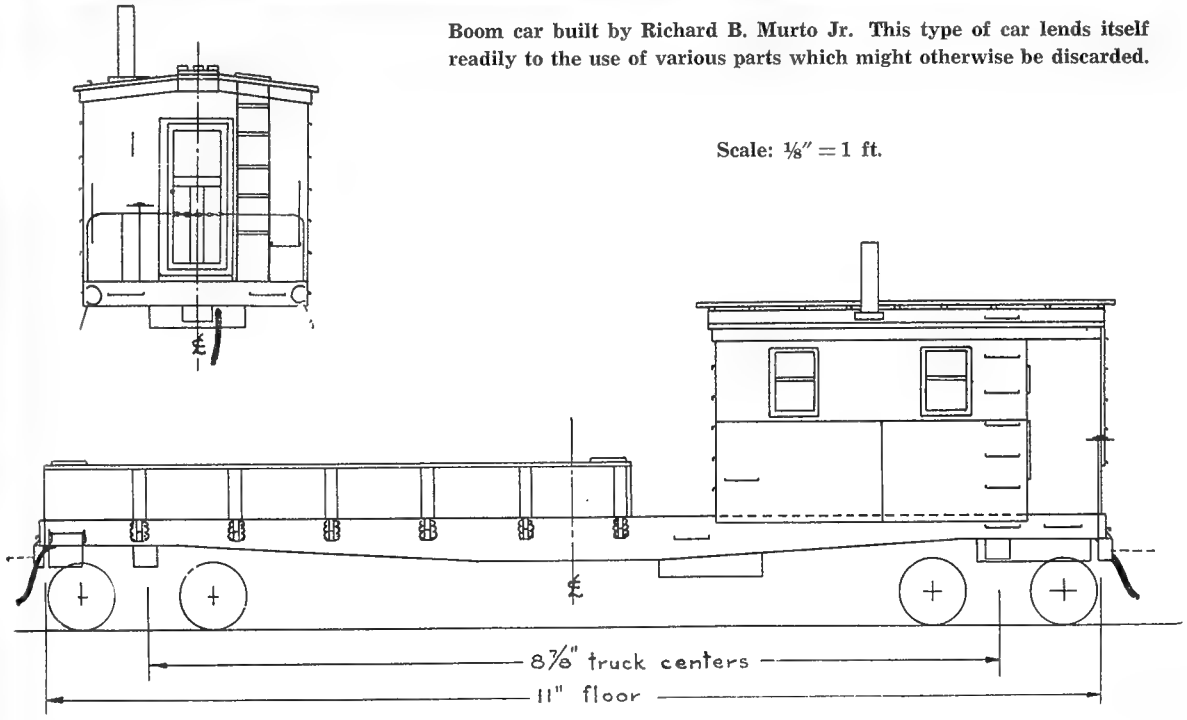
Dump Cars.

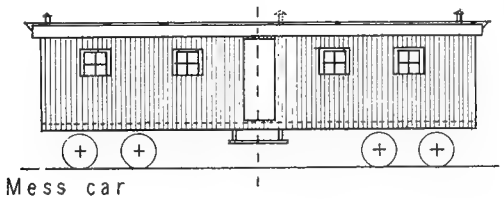
Dump cars are of many kinds and are used for track ballasting work, when the load is dumped on to the trackside, and again for making trestle fills, when the dirt is dumped over the sides of the trestle until the intervening depth of the cavity is filled up. They are generally arranged nowadays so that when the body of the car tips sideways the sides are simultaneously raised to clear the contents of the car. Dumping is sometimes by means of hand levers, sometimes by air pressure. It would be possible to build a dump car on the lines of that shown on page 88 for O gauge with an arrangement for electric operation. A very small solenoid might be found on an old midget bell, or the coil of it rewound for an adequate amperage for the purpose. But for the use on a model

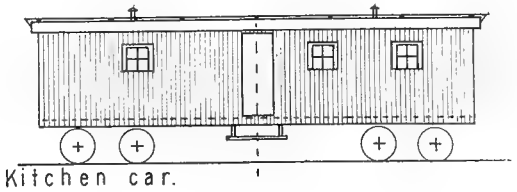


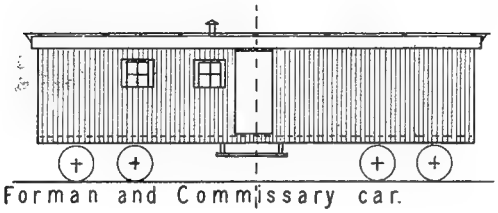
Boom car built by Richard B. Murto Jr. This type of car lends itself readily to the use of various parts which might otherwise be discarded.

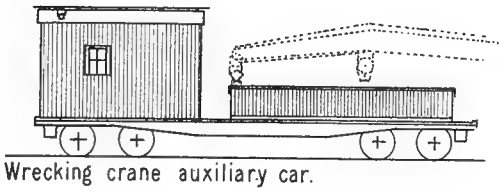
Scale: ⅛″ = 1 ft.







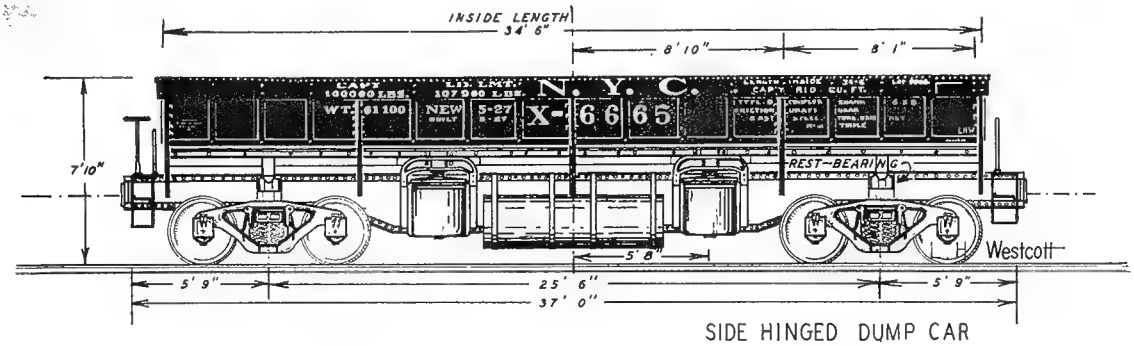




layout this does not seem particularly necessary; it would be essential to arrange a wipe switch for remote operation, and at all such places as this would be desirable it would be better, no doubt, to use a hopper car. Dump cars are not commonly used in any sort of mineral service, and it is only in such service that a remote control dumping arrangement would seem to be wanted. The car shown will also serve admirably for a dummy type of car which may of course be arranged to operate mechanically if necessary. A train of dummy cars comes in useful in scheduling special runs for a construction job.

Telegraph Train.

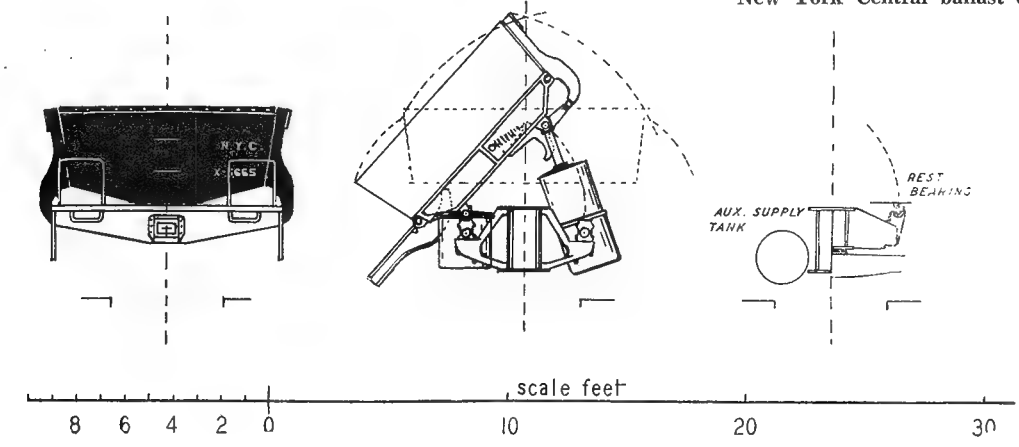
A telegraph train formed from disused cars of not too recent vintage is shown on pages 89 and 90. The pole line wire plant along the right of way of various railroads constitutes the major portion of the Western Union Telegraph wire hookup. To provide facilities for the construction and maintenance of this maze of wire, the company

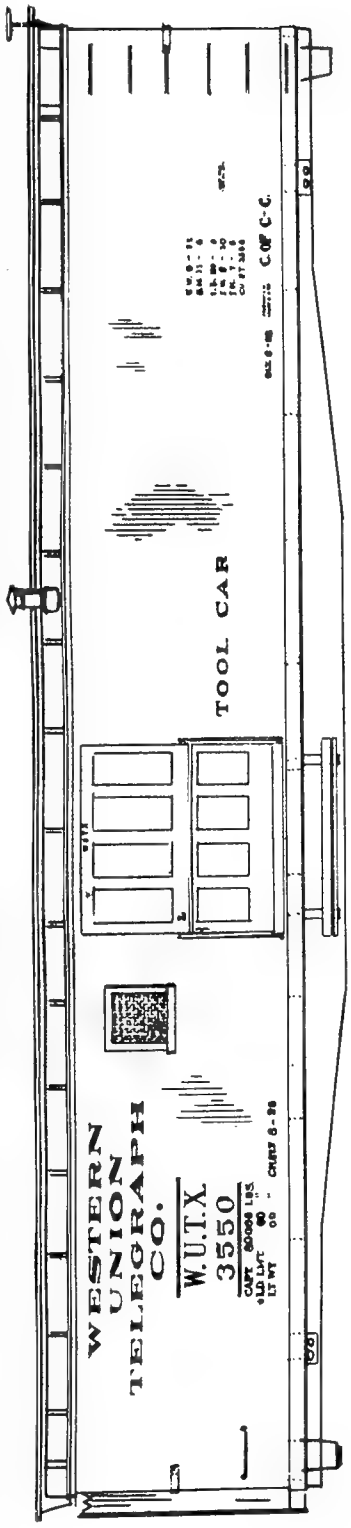


SIDE HINGED DUMP CAR

⅛″ scale.

New York Central ballast car.



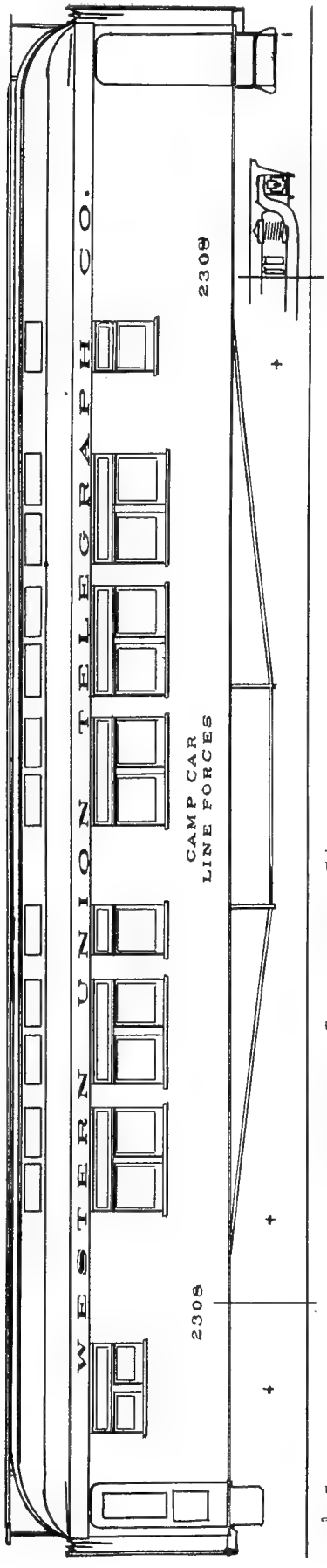


Western Union tool car.

maintains about 70 camp outfits, each consisting of a sleeping car, a dining car, tool cars and (where the outfit is assigned to a locality where pure water is scarce) a water car. The sleeping car is also a recreation car and is furnished more or less for the entertainment of the men in off duty hours. The dining car includes washing facilities and the cook's accommodations. Part of the tool car is used as a refrigerator for perishable foods and is provided with a lighting plant for the entire train. The water car is usually a 10,000 gallon tank car. Each outfit is permanently coupled in the following order: sleeper, diner, tool car and tank. The sleeper accommodates 16 men, and if the gang includes more the sleeping car is duplicated. There is a diaphragm between the refrigerator portion of the train and the next car. The construction of such a model outfit seems to require no special elucidation. Made up sides may be used for sleepers, or a judicious selection of standard car sides can be made to almost approximate. The builder should consult for this purpose the charts given in the various catalogs, which show the general outline of the sides of numerous types. The tool car follows a box car design, and the roof of the sleeper, it will be noticed, is equipped with running boards as on a box car.

Workmen's Hand Cars.

Workmen's cars, such as are seen all along any track, and often called hand cars, are either of the push type, being pushed up inclines and controlled with brakes on the down grade, or of the lever propelled type. Unfortunately, the levered type does not readily lend itself to a model layout. It never runs unless controlled by a human being, and nothing would seem more absurd than a model that ran along the track with moving levers and no human figures in control. It might be possible to include mechanical scale figures, but this would be futile without some form of power propulsion; and unfortunately there is no motor small enough to accommodate itself on the underframe of a lever hand car. The push type of car will make a useful added feature to a trackside. A gasoline driven car can be easily built up around a Walthers MU mechanism, using the centrally located seat box



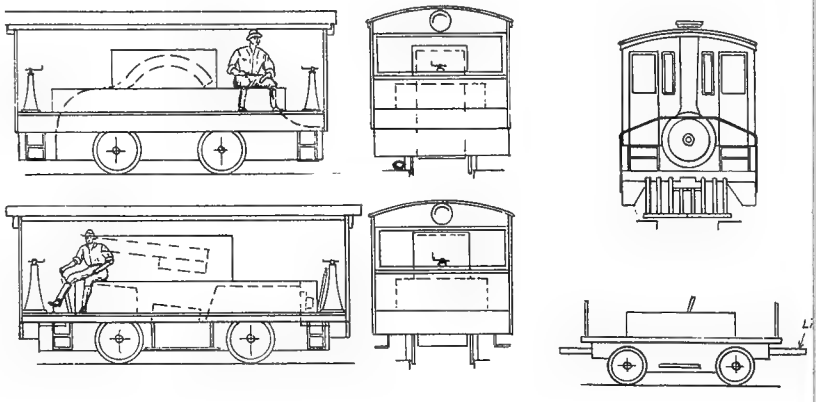
to cover the motor. This serves its purpose very admirably.

Inspection Locos.

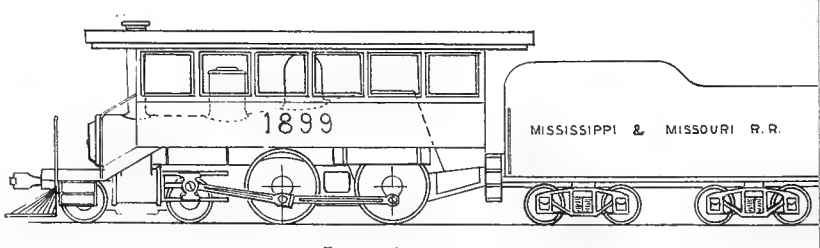
The old converted pre-historic engine type of inspection car, as used on the Central Railroad of New Jersey, is irresistable (see below). There are surely few more interesting units running on rails. It would be very easily modeled in HO or any other scale. For HO, any type of mechanism might be used. A photograph of this engine appeared in Railroad Magazine for June, 1935. One or two similar examples have run until worn out on logging railroads. It is a model well worthy of construction. An ancient type of ornamental dome and a very high sand box should appear inside the windows of the saloon.

Steam Shovel.

Many railroads use steam shovels for innumerable purposes such as clearing away snowdrifts where a plow is unnecessary, digging out slides, and other work. The one shown on page 91 has a business-like appearance at a locomotive roundhouse yard. They are not difficult items to construct. The



Motor cars.

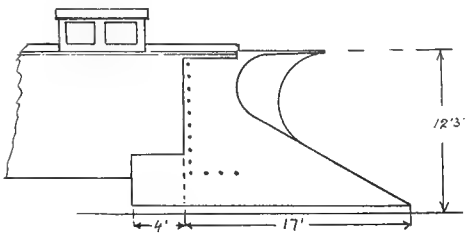


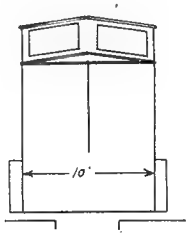
Inspection locomotive.

jib need not be latticed with struts, but may even be built up of plain stripwood. On a flat car, as a permanent fixture, the cab would not require to swivel, since the bucket does not extend beyond the flat car deck, and would therefore not need to have an auxiliary car to take its weight. The bucket itself can be built up easily of tinplate or brass sheeting. The cab can be of metal or thin wood. At a medium sized locomotive depot, such a shovel is often used for coaling engines, being hauled along by the yard goat.

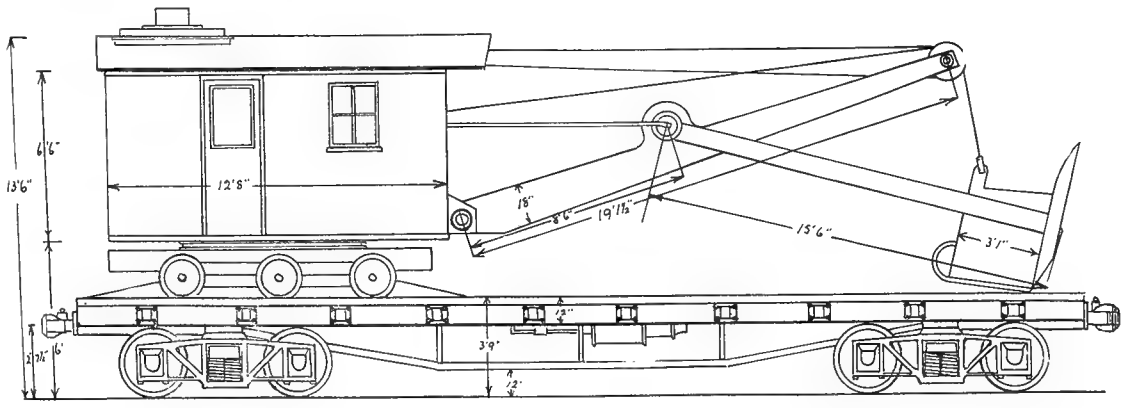
Snow Plow. For indoor layouts there will never be any need of the services of a snow plow, though on outdoor sytems there might. Yet a model of a fixed plow of the pusher kind is a satisfactory addition to equipment. At most engine depots in the North plows of this kind will be found. The wedge type of plow is a simple job. An old caboose can be used as the basis of the design if desired. Or a caboose-like vehicle can be specially built for the purpose. This should be the eight-wheel double truck type, and the plow is a non-moving appliance which attaches to the end of the vehicle. In making the plow itself, a good scheme is to cut out the parts first from cardboard, securing in this manner a perfect fit by the cut-and-try method. When the card pieces are correct they may be dismantled and the pieces cut from brass shim and soldered up. The plow is then attached to the end of the car.

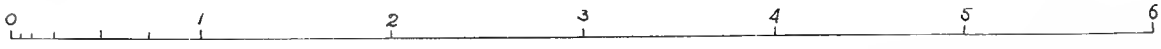
Wrecking Crane and Train. A wrecking crane or "big hook" forms a most spectacular feature on any layout and should not be omitted. The design given (page 92) represents a Bucyrus type of 200 tons capacity and is fitted with extensible jackbeams at each side. Its boom is of such a length as to require the services of an auxiliary car for carrying it when in transit. The best material for such a crane is metal throughout, and the handiest method of cutting out the cab sides and the sides, ends and floor of the crane car, as well as for cutting all specially shaped sides for rolling stock, is that of making paper templates, sticking these on the sheet metal to be used, and cutting the metal accordingly. The writer has used this system for many years for making well cars, and it is admirable in that the pair of sides can be cut in paper together and thus be exactly alike. In cutting the papers for the cab, cut also the window apertures and doorways. Bend the cor-

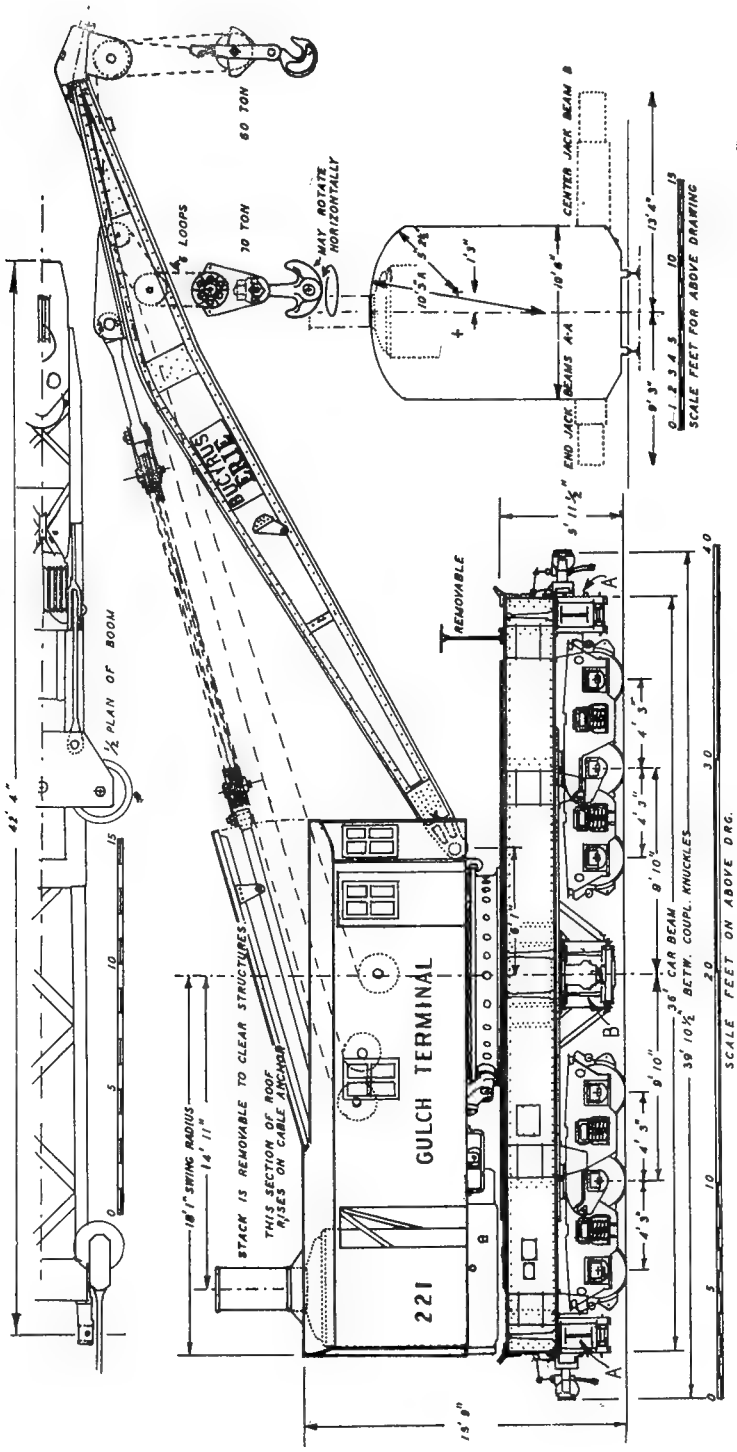




Left: Pusher type snow plow. (Mount on old flat car or caboose.)
Below: Railroad steam shovel.





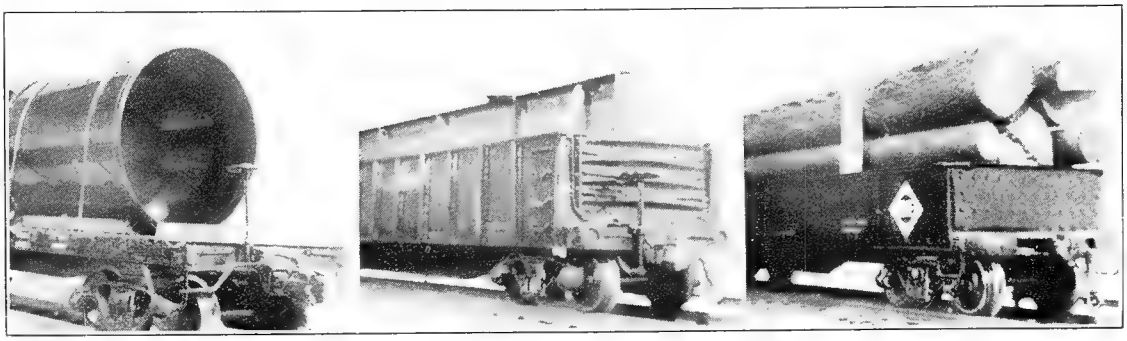


Bucyrus-Erie Crane.

ners either in the vise jaws or by gently hammering the metal around a wooden block of correct thickness. The windows and doors may be cut while the papers are still on, by drilling small holes on the inside of the lines, thus separating the piece and afterwards filing the edges. Nice window frames can be made for O gauge by using very small brass angle. For smaller work use half round wire soldered along the edges outside. The roof can be cut to a paper pattern which has been made correct size by experiment. For the revolving base below the cab a discarded brass wheel, or a pair of locomotive wheels sweated together with the flanges outwards, may be used. Failing this, a piece of suitably sized brass tube with a tinplate or brass plate over each side may be satisfactory. The cab should be soldered on to this turntable, which should first be accurately centered and bored for the pivot bolt. The advantage of using wheels is that the holes are already centered and made. It is necessary to make the cab movable about the pivot.

The boom itself can be soldered up from 1/16" brass angle having cross struts on the upper and lower sides. Brass strip, ready cut and shaped, can be had for these. Pulleys may be obtained from model ship suppliers or turned up to suit. The 60 ton hook will require to be built up to some extent; the outer hook may be a model ship's jib block, and one of these fittings may form the basis of the inner hook. The building of the frames of the carriage is carried out in thin brass sheeting with angle brass along the top and bottom edges of the sides. If so desired, this edging can be left out and the projecting edges of the floor made to serve, along with a strip soldered along the base edge. The jack beams may be either dummy or working features. In the former instance they are easily soldered up with square and shaped pieces of brass; if they are to work they should be built up in simplified form out of sheet metal. But they will be of no real value as working features. Coupling and safety fittings are normal. The trucks used are of the six-wheel Buckeye type, which may be had from Scale Model Railways of Huntington or Lobaugh of San Francisco. It is suggested that HO gauge Hudson tender trucks may be employed for the smaller gauge. Or, if something heftier is wanted, use OO gauge Hudson truck sides with the HO gauge of wheel. These, however, may be found too heavy in appearance, and in any case would have to be partly concealed inside the car frames.

The design for the auxiliary car is on page 88. A good scheme for a crutch on which to rest and retain the jib is to use a white metal spoked wheel such as is sold commercially on farm toys. Take two of the wheels, cut off all the spokes near the rim, so that the rim falls off, leaving the spokes and hub intact. Then cut off all but three of the spokes from the hub, file up the piece that remains and, having two, you have a pair of three legged metal trestles. These can be soldered to the floor of the auxiliary with an axle to bear the weight of the boom. The hubs will tend to retain the boom on curves of the railroad, but if not sufficient in themselves an upright pin may be soldered on each trestle and cut off leaving a length of about 1/4". Better still, an additional spoke may be kept on the hub, opposite the central one of the three spokes forming the trestle. The chains may be made of ships' chain, 20 links to the inch or finer. Dime store jewelry chain will also do.



Some scale loads.

We come now to the subject of special load cars, and anything like a pretentious treatment of it would be out of the question here. Every large railroad has its own types, built to the special purposes to which the freight traffic of the system happens to be devoted. Many common flat cars are so sturdily and heavily built that they serve special purposes without much adaptation. High or low struts on a flat car's sides often equip it for cumbersome or heightened loads. But all manner of freights require to be transhipped by rail, naval guns, bridge girders, electric transformers, tanks up to more than 10 ft. in diameter, logs, and even houses. While flats and gondolas are largely employed in this service, there is one type of special car that is fairly frequently found in operation, the well flat car. These may be said to vary much as the common flat, in that the well is sometimes placed inside the center of the vehicle which then has straight sides, and sometimes the well extends from side to side.

Well Type Cars.

Use for the cutting out of the shaped girders the paper pattern scheme. Tinplate or brass shim will serve, and this may be flanged with tinplate or brass strip soldered on the inside, forming an I-section girder all around. If so desired, the ends of a standard white metal cast underframe may be used to form the bolster beams for the trucks and the coupler pockets. This can be soldered under the metal floor. Sometimes the floors of these cars are solid all through, sometimes they are solid at the elevated ends only and cross strutted in the center, sometimes they have also the elevated ends without floors, the girder work showing much the same as the ends of an oil tank car. It is possible to use the underframe ends of an oil car for this purpose, soldering these between the side girders, and these underframes are modeled so as to include the coupler channel. The small metal tank cradle can be filed off if necessary.

A series of useful sketches (page 95) depicts various methods of loading unusual freights on the orthodox flat and gondola car. The latter are used for railroad ties, which are loaded diagonally on their ends. Machinery such as tractors and farming implements are loaded on flats, being strutted and chocked and chained in place. For the carrying of tan bark and similar commodities a gondola might be provided with raised trestle sides as shown. Tanks of the cylindrical type are chocked in place on flats and chained to the side rings. Flexible steel plates, roof trusses, cases of plate glass and short logs are also shown. For overhanging loads there will be an idler car running under the overhang, and for round articles of larger proportions, steel plates, ship propellers and so forth, a special timber trestle rest is placed on a flat.

Special Loadings.

Many of these special loads can be very easily and effectively modeled for the purpose. Actual railroad ties of the stated gauge can of course be used, and they should be creosoted. Scale tractors can be had from the dime stores and repainted or even rebuilt to give the correct appearance. Galvanized iron tanks can be made from doweling covered with corrugated iron sheeting, which can be had to scale for O gauge, or, in HO gauge there is a corrugated iron aluminum paper. Roof trusses can be built up from 1/16" square section brass. Logs can be cut from rose bushes, and other timber from strip wood. A dummy steam shovel in wood and cardboard makes a striking freight for a well car. Pulley wheels, gas-pipe brass fittings painted red oxide, strips of cardboard folded into angles, and many other small fittings, are useful.

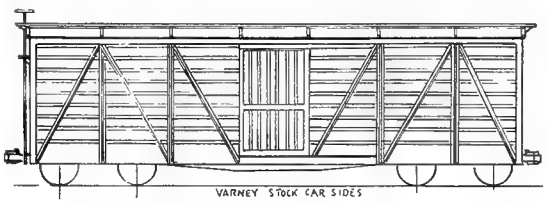
Containers are now quite common in this country, though probably not quite so much in evidence as in Britain. An overdose of them on a model layout is not desirable; they can be easily overdone. But to show that there is an excuse for their being on a model pike, a number of prototype container cars were delivered by the American Car & Foundry Co. to the L. C. L. Corp. for use in the transportation of cement or other commodities, and are capable of being unloaded by air pressure. The containers are of all-welded cylindrical construction with a convex head. Each container has a manhole in the side, and a safety valve is located in the head to relieve pressure. An opening with a door is provided at the bottom for access to

Containers.

valves controlling the activating air jets and piping. The cylinders are 7′-6″ in diameter, with extreme height over top inlet cover of 9′-2¼″. They are conveyed on special gondolas carrying six containers. Each side of the car is provided with five square holes for admitting the air hose. The insides are provided with guides to prevent movement of the containers in transit. The cylinders may be built of doweling with convex wooden cappings as supplied for furniture work. For HO gauge the ends of wooden tank car bodies can be used to form the tanks.

Animal Shipment.

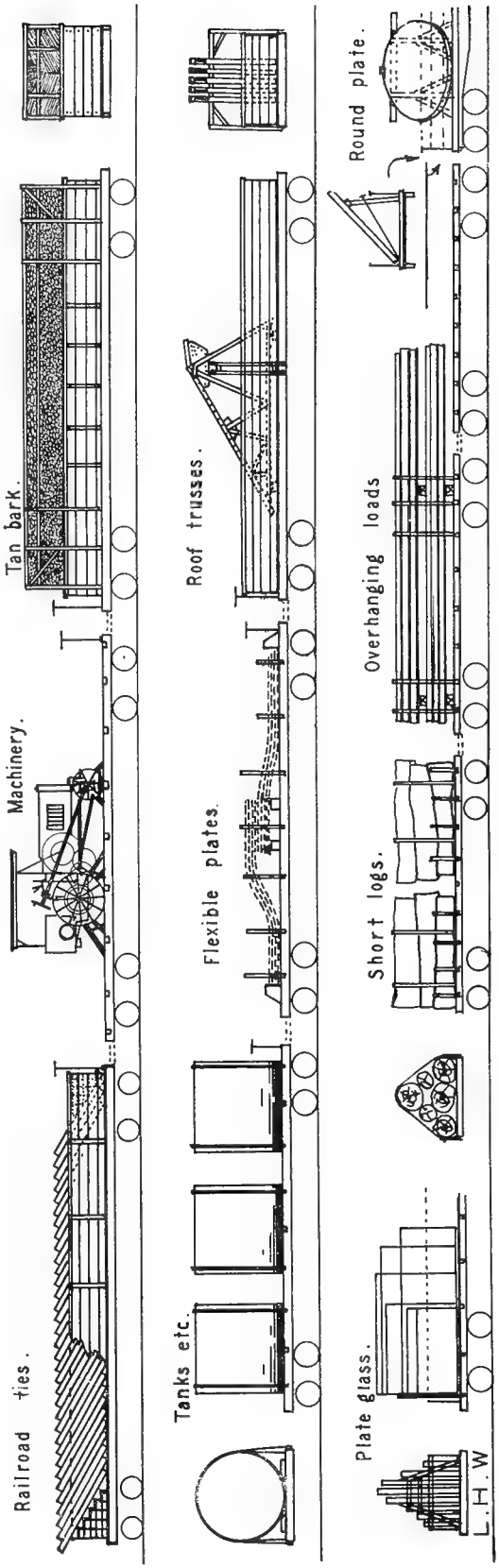
The transport of animals of all kinds on railroads is always a fascinating business, and many historic shipments have been made. For horned stock the common stock car is used, whether farm stock or range cattle. Elephants are shipped in end door baggage cars. Horses and pedigree



stock are carried in cars fitted with stalls. Sheep sometimes have double deck cars, though hogs are usually shipped in single deck conveyances as they very quickly succumb to heat and crowding. Circus movements are very interesting; circus wagons, etc., are loaded on flats, but there are many special circus cars. Some of these are over 70 ft. long. They are privately owned by the show people and bear their names. Scale models of domestic animals are now obtainable in several dimensions and can be had for all gauges. A herd of cattle lends a real lifelike look to a stock pen.

Logging and Industrial Railroads.

There is also a real charm about a model of a logging line or industrial layout adjoining a main line of railroad. These roads are fascinating in that they often use quite obsolete locomotives bought up from various railroad companies and have cars of unique design. As a side feature they are well worth considering.



9

Painting and Lettering.

THE paints that are sent out with locomotive and car kits are well known to railroading fans who have purchased these things. They are usually bottled in glass with screw bakelite stoppers and the colors are already toned and suited to the job. But it is a different matter when paint has to be obtained by the amateur himself according to his own selection. The precise tints required on stock for the respective companies is a most delicate matter to decide, and even if one is provided with a specimen panel or swab as a guide it is another question altogether even for this to be matched and an accurate match may give a wrong effect due to optical illusion. There is more than one railroad modeling firm sending out completed and otherwise beautiful models which are hopelessly wrong in their color tint.

Model Paints.

No glossy paint should be used on a railroad model unless the car is intended to look as if it were fresh from the paint shop. By going to a reliable firm for paint, whether for an engine or a car, one is generally sure of getting the correct thing. Such paint must cover well with a thin coat whether applied to wood or metal surfaces, and must be capable of taking one coat on top of another. The writer prefers an oil paint to a cellulose color anytime. Hobby Industries, of Milwaukee, and Varney have especially good specimens; Cleveland Model & Supply Co., Walthers and Scale-Models also are reliable.

The novice will be aware that on many freight cars there are large reproductions of the particular company's herald. These heralds are familiar to the general public, but few are aware of the romantic history attached to some of the designs. The need of these was first felt when all the railroads were known merely by a string of baffling letters. These heralds were therefore evolved early in railroad history and the earliest ones used are often extremely dignified and attractive apart from mere advertising capacity. The heraldry behind other devices dates back to pre-Christian times. To discuss the Santa Fe, the MKT, the C&A, and scores of others is no task for us now. But it is good to know that nearly all these crests, along with the accompanying lettering for freight cars down to the minutest "capacity" notes, can be had in transfer form for all the popular scales. These are really an excellent medium for lettering models. Not only can these be had, but separate letters for car and coaches in several colors are also on sale. Firms like Hobbycraft, Walthers, Lange and The Model Railroad Shop should be approached for details of their productions.

Commercial Lettering Equipment.

A few simple hints may be given as to brushes and utensils for the paint shop. Keep paint cans tightly sealed when not in use. Have on hand at all times a good supply of turpentine for mixing and for cleaning brushes. Keep all brushes scrupulously clean, washing them in turpentine immediately after use, rinsing them until clean, and occasionally giving them a wash in soap and water. They will last ten times as long. Have a complete set of graded brushes if you can, brushes of the artists' type. Also a few larger and perhaps cheaper ones. A good brush is

Tools and Brushes.

half of the battle for good painting effects. Cheap waxed paper cans for washing out brushes and for mixing small quantities of color are to be found in discarded ice cream containers. These should be washed and stacked away for future use. When used for paint they can be thrown away without worry. Empty tobacco cans, as small as possible, are also useful. Never use a paint brush for varnish, or vice versa. Have special brushes for special purposes. Also, if possible, have some brushes that you use for blacks and grays and browns, and others you use only for white and yellow. Don't get them out of their proper order. When not in use, keep your brushes standing in a large empty jar with their business ends uppermost. This will prevent any mis-shaping of the bristles, if they have first been cleaned.

Cleaning Off.

Before painting a locomotive (we are assuming that it is made throughout in metal) it will be necessary to cleanse it thoroughly. This can be done on a new job by washing it in Oakite, which will not only remove dirt but greasy finger prints. But when it is a repainting job the matter is different. The best thing to do is to remove the mechanism and wheels—that is, the chassis complete—and put the remainder into a covering bath of caustic soda, only mind your fingers and clothes. It is useless to attempt to produce a good painting job on work that has not first been perfectly cleaned off. Caustic will remove everything but the metal.

Spray Painting.

For locomotives there is nothing to equal spray painting; it leaves a natural looking finish when properly done. Inexpensive sprayers can now be had, and air can be supplied to these from an inflated inner tube. Such paint must be carefully thinned before use, but if it is too thin it will run, and become streaky. For a one-color job the paint spray is unequalled. With a dull flat it leaves a perfect mat surface; with a semi-gloss the finished work bears no sign of brush marks, bristles or dust.

After the first coat, which should be rubbed down with sandpaper when quite dry, a second coat should be laid on. When this is dry, the lettering may be applied. Generally speaking, engine varnishes need not be used. They are far too risky in their quality and texture. A dead paint finish, properly set on, looks more effective. But if it is desired to varnish, over transfers or hand lettering, the varnish must be best artists' varnish, very thin and far from any appearance of gloss. The writer has found great usefulness in a spirit fixing solution that gently enriches the tint of the colors and effectively fixes the letters without adding any gloss whatever.

If brush painting is resorted to, use new brushes well soaked for 24 hours in cold water to fix the bristles; use soft camel's hair brushes only.

Painting Cars.

Before painting a wood car, all glue must be thoroughly cleaned off the joints and out of scribe marks into which it may have flowed. Metal parts should be cleaned with gasoline or benzine and a clean cloth.

The all-metal car can be treated by first removing any corrosion with emery cloth and then washing it in hot, soapy water to cut grease and acids. Then rinse well in clean water and allow the car to dry thoroughly without touching it. Handling now would coat it with a thin film of oil which sometimes causes trouble. A good scheme is to take the car to an electroplater and have it cadmium plated; this makes a better base for the paint.

The trucks should be removed and painted by hand with a small water color brush. Be careful not to get paint into the journals. Wheels in real cars are not intentionally painted, but with modern spray painting many times get a good coat, so you can paint the wheels or not as you please. Don't paint the treads, and if any paint flows over them wipe it off before it dries.

The car body should be painted with a standard model paint or with an oil lacquer. Do not use a regular enamel or lacquer, as these obscure the detail. A dull finish can be secured by giving a coat of dull finish varnish as the last coat. If regular oil color is used for painting, the finish is less glossy and more realistic.

You can use either a spray outfit or brushing, to suit your taste and facilities. Spraying is more satisfactory.

Don't paint the couplers if they are auto-

matic, as paint gums them up. If they are dummies, paint them last and they can be used as handles while you are doing the rest of the car.

Getting a Weathered Look.

While on the subject of model railroad paint jobs, one point occurs to us most often as we look at freight car and locomotive models. The paint and lettering jobs are too fresh and too perfect. All model railroaders can benefit by closer observation of real railroad equipment. It never hurts to look as often and as much as you can. And this matter of outward appearance of cars is one thing to observe if you want the kind of realism in your models that will make people exclaim over them and realize that here is something entirely different from toy railroads.

Not one freight car in a hundred, or even that high a proportion away from the shop cities, is glossy. Too glossy a paint job is the most common fault of model railroad equipment. As an exhibit piece a model car looks fine with fresh lettering and a glossy coat of enamel, but not as a piece of realistic model railroad equipment. If you want exhibit pieces, all well and good, but if your aim is building up a complete model of a railroad system, use dull finish paint; mix the colors darker to represent the darkening of soot and age. Make the lettering accurate but cover small portions of the letters so that they look worn. Keep the shop dates and perhaps the car numbers fresher looking on some cars, for these items are often repainted on real cars. Simulate rust color on couplers, uncoupling rod, and safety appliances.

Note that model freight cars cannot be left to acquire an old and worn look. Unfortunately they acquire dirt in the shape of fingermarks and splotches rather than more or less evenly over all. The model railroader must build his cars with the proper old look to start with and keep them that way, just as he builds some cars with the proper new look and keeps them that way.

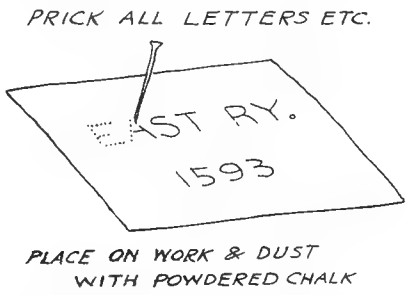
With locomotives the idea of realistic dulling and discoloring applies just as much. Study of locomotives will reveal various discolorings due to local conditions and types of service, and also peculiarities that are caused by the operating conditions on different railroads. Streaks of boiler compound on the outside of the boiler, dust and dirt from the ballast on freight engines that aren't well kept up, and well shined boilers on passenger engines are some hints.

Unpainted Parts.

It is a common mistake amongst amateurs to paint those portions of cars which should be left to represent bare boards. Make absolutely sure, if possible from personal observation, whether the inside of the actual car is painted or not, and if the underside of a caboose roof is painted. Far better than paint for these surfaces is a coat of creosote which looks exceedingly well in model work, especially on bridge decks. It can be just as effectively used on cars. But do not use creosote if in the actual car the work is left bare. Leave it bare just the same, unless of course you are using metal where wood is used. Creosote is good for simulating weathered bare woodwork. A better plan is to dirty down the white wood surface with soot and water or with a piece of soft clay.

Lettering by Hand.

We have already mentioned the idea of using a reading glass rig for this fine work, and another useful idea is offered here. To the inexperienced it may be a help to make a pattern first of the lettering to be done. This is accomplished by



pricking out the letters with a pin on tracing paper or ordinary writing paper. The paper should be held on the work firmly while rubbing into the perforations powdered chalk. After the pattern has been removed it will be found that a perfect representation of the lettering in dots remains. In making lines, a draftsmen's pen or an ordinary writing pen is used by many with remarkable success.

Here the paint should have exactly the correct consistency not to drip off the pen too freely and not to adhere to the pen too stubbornly. Keep the pen well away from the straight edge.

For ordinary and orthodox painting and lettering the following notes will be found valuable.

After the car is painted and dry, rule the guide lines for the lettering with a sharp pencil having a fairly hard lead, using a straight edge. Never rely on your eyes to give a straight line. The guide lines should be drawn for both the top and bottom of the lettering. Make them as faint as possible because they will not be taken out. And remember, lettering a little smaller than actual size will look a lot better than if the letters are made too large.

Now that all the guide lines are on, go over the entire surface to be lettered with a damp cloth to remove any grease from the hands. Do not touch car surfaces any more as a spot of grease will defeat your efforts. Now for the color. Show card color is ideal. A chrome yellow is a good second for gold leaf, or use Devoe's gold show card paint. Mix water with the color until it is fairly thin.

Use a Gillott 303 steel pen and burn the point with a match until it is dull red. Allow it to cool. Do not plunge the point into water as this will temper it again. With a drop of color on the point start the lettering, following the prototype as closely as possible. Wipe the point dry of color very often as the color dries quickly, and if a clear point is used a better job will result.

After the job is completed, if the car is to be glossy, go over it with a coat of white shellac. This gives the necessary shine and will protect the lettering. If the car is to be dull, leave it as is. Locos are painted the same way. The entire loco is painted flat black and after the lettering and numbering is on, the entire loco except the smoke box is shellacked. After a few weeks the shellac takes on a semi-gloss finish which is just about ideal.

Another wrinkle to use when lettering is to give the wrist and hand support for the task. If the model is 2″ high when laying on its side to be lettered, make up a support also 2″ high on which your arm can rest while lettering. And go slowly.

Now for a few wrinkles for letters. Never accentuate horizontal lines. Always accentuate the sloping down strokes which run from left to right, but for a single exception, the case of the letter Z, where the single sloping line will be the only one possible to accent. Always accent the directly perpendicular lines except the letter N, and the first line of the M. On round letters the accents should occur at the sides of the circle, or on the upper right and lower left quarters. And always finish the free ends of the lines with a serif or cross stroke. This enhances the general squareness and finish.

Proportions of letters can be varied greatly, but for railroad lettering a wide or extended letter is best. These proportions will be found satisfactory. Taking a height of ⅞″, letters A, D, H, N, T, are $^{8}/_{12}$″ wide; B, J, P, R, Y, are $^{7}/_{12}$″ wide; C, G, K, O, Q, U, V, X, Z, are $^{10}/_{12}$″ wide; E, F, L, S, are $^{15}/_{24}$″ wide; and M, W, are $^{13}/_{12}$″ wide. These proportions can be reduced for any size wanted.

Transfer Lettering.

For fixing the commercial transfer lettering it is good to have at hand a few clean blotters, a pair of small eyebrow tweezers, a cheap water color paint brush specially kept for the purpose, and a clean cloth or handkerchief for drying the fingers.

If the legend is lengthy, it is well to cut the transfer into several pieces in order to avoid trouble with the curling of the papers. The name "New York Central" would, for instance, be divided into three words. Apply the transfers according to the instructions of the particular manufacturer. Transfer lettering can be applied without that telltale haze by using spar varnish first on the car, then applying the transfers, and after 24 hours giving the car a coat of Speedflat varnish.

10

Maintaining Rolling Stock.

ONE of the most important questions in connection with the maintenance of locomotives and rolling stock is that of how to secure free running. Nothing is easier than to be experiencing hauling trouble without being entirely aware of it. There are a hundred little things that may happen to cause this, and the ideal is to see that none of them gets a chance. Smooth running only comes with careful planning and observing of the movements of trains.

Locomotive Troubles.

There may be dragging in the trucks of locomotives or cars. It is good to take a pair apart and to see what the bearing surfaces look like. Do not follow the mistaken policy of running in new wheels without oiling. Use a little light oil from the start. Or, better still, before fixing any truck, if it is not a ready built and perfectly running one, take it to pieces, twist a drill by the fingers in the bearings and insert a blob of lubricating paste. Something of the graphite order is best. See that the wheels are not rubbing anywhere on the truck frames; if they are, insert a very thin and tiny washer to prevent this. See that any distortion of the axles is filed down so they run smoothly in the journals. See that journals are absolutely square with axles; the slightest disparity will cause binding if the bearing holes are not sloppy. The wheels should spin continuously with a finger snap while the truck vehicle is being held. After service for some time, flush out the bearings with cigarette lighter fuel; you can use the air pressure container for this job. Bolsters should never rub directly on to a wooden surface; place metal rubbing plates or insulated ones between. A good push should send any car all around a room on a level grade.

Poor Track.

Only the most accurately laid track does its work in contributing good running. See that everywhere the gauge is right. On curves it should be very slightly wider than on the straight. N. M. R. A. standards must be closely observed in every detail of track laying; be content with nothing else. Insure that there is perfect track level by getting the eye right down to it, and level it up by shimming where necessary. But this ought not to be necessary. Nothing makes for resistance so much as irregularities at curves.

Thrust bearing troubles on worm drive are very common. There ought to be thrust bearings at both ends of the worm shaft of a locomotive motor. Ball thrust bearings, which can be bought commercially, are best of all. This is one of the very commonest ailments that make for resistance of movement; sometimes the resistance is simply enormous. Side rods are also important. Drivers need to be accurately quartered, and the holes in rods must be exactly the distance apart of the wheel spacing. The least discrepancy will cause jerking, binding and pounding. With a rigid type of frame, driver bearings must be accurately in line. Many types nowadays have sprung bearings for drivers, and some discussion has centered around the subject of whether these really aid adhesion and hauling. To the writer it seems that there can be no real doubt about this. It is held that, no matter how many wheels are gripping the track at a given instant, there will be the same amount of adhesive weight somewhere on the drivers at the same time. If one pair

of wheels is not fully engaging the track there will be a proportionate increase of weight on those that are. But this theory apparently does not fully hold as experiments have shown sprung locos to pull more than unsprung ones, all other things being equal. The amount of driving surface of wheel rims on rail is an important factor.

All motor bearings must be regularly oiled with light lubricant. If too much oil gets in, the surplus should be absorbed with a blotter. Watch the wire leads to the commutator segments. Sometimes one of these will come loose through overheating, and starting and pulling will be different if the fault has not been corrected. The wiping contacts of a control and reverse switch should also be noticed to see if there is good contact; also the screw terminals on such switches. It is also absolutely imperative that the brush faces shall be bearing squarely on the commutator.

Derailments.

It is a profound mistake to assume that for the smallest gauge it is not possible to obtain freedom from derailments. All that is needed for HO gauge in this particular is exactly the same amount of care as for larger scales. The ex-tinplater or O gauge worker is always in danger, when he comes down to HO, of imagining that anything will go. Nine times out of ten, of course, derailments are due to track trouble. It often has its roots in the track board itself, or in some form of uneven ballasting material which twists the track. Rail joints get out of alinement. Especially on curves these must be watched. S curves should be scrupulously avoided in track laying. They ask for coupler troubles unless a section of straight track is used between the curves. Notched rails for switch blades are good enough but if the notching is overdone there will be a bump for every vehicle passing over. Couplers must be set as far as possible at identical heights, and the shanks are best cut off as short as the pocket will allow. Big radius curves are also the thing to aim at.

Cars should not be built too light. The correct principle is that the heavier the car the better is the adhesion, and this should be borne in mind even though other factors bear upon the matter of weight. The center of gravity should be just near the floor level, and the solid metal underframe idea gives about the right balance. An excessively light car will never really "break in" its own bearings.

Sun, Damp and Dust.

Finally, beware of the effects of sun, damp and dust. These are the real foes of good running. The ordinary house variation of temperature will tend to dislocate track tremendously, especially during the first year of its existence. A gap should always be left between rails sufficient to permit expansion. If the track is laid in Summer months the gap should be very small; if in the Winter it should be large enough to allow for Summer temperature. Even then, during the first Summer or Winter you will have to go over it for adjustments. The writer has frequently had to take out entire curves and discard them for this reason, notwithstanding the forethought that was exercised when they were laid. Damp will swell the baseboard and tend to twist it. This points to the need of something other than deal planks, and the writer has long ago discarded these in favor of a pulp composition wall board. There are many varieties on the market, and the material is cheaper and better than wood. Dust on a track makes running impossible. There is nothing so useful as a hand type vacuum cleaner for going over the entire surface of the layout periodically unless loose ballast is used, and after each operation the rail tops should be cleaned with a gasoline-soaked rag and sandpaper. One of the strongest arguments in favor of two-rail is that cleaning becomes a pleasure, where with a third rail it is a very different affair.

Manufacturers of Model Locomotives, Cars and Parts.

[Please note that this list does not include manufacturers of electrical and auxiliary equipment with which this book is not concerned.]

Adams Manufacturing & Supply Co., 3626 S. Gramercy, Los Angeles, Calif.
American Model Railroad Co., Inc., 32 Avon Rd., New Rochelle, N. Y.
Auel Industries, Irwin, Pa.
M. B. Austin Jr., 538 Meadow Rd., Winnetka, Ill.
Thomas G. Bedell, Windsor, Vt.
William Beeman (Rail-Craft), 39 Algonquinwood, Webster Groves, Mo.
D. N. Bradley, 212 4th Ave., Joliet, Ill.
L. D. Cameron, 1316 S. Hoover St., Los Angeles, Calif.
Cleveland Model & Supply Co., Inc., 4508 Lorain Ave., Cleveland, O.
Charles A. Cole, Ventura, Calif.
Comet Model Co., 129 W. 29th St., Chicago, Ill.
Congress Tool & Die Co. (Min-I-Scale), 9016 Lumpkin Ave., Detroit, Mich.
H. J. Coventry, 2701 Talbot Rd., Baltimore, Md.
R. D. Denise & Co., 424 E. 92nd St., New York, N. Y.
A. De Pippo, Box 391, Hoxsie, R. I.
Lynn Drummnd, Box 399, Augusta, Ga.
Merle F. Faber, Millbrae, Calif.
Famous Model Co., 2 Roosevelt St., Baldwin, N. Y.
A. C. Gilbert Co. (American Flyer), Erector Sq., New Haven, Conn.
Graceline Model Railroads, P. O. Box 2621, Minneapolis, Minn.
H & S Model Supply Co., 714 Julian St., Detroit, Mich.
Hawk Model Co., 3521 W. Fullerton Ave., Chicago, Ill.
Hobby Industries, Box 832, Milwaukee, Wis.
Hoffman's, 3048 Kensington Ave., Philadelphia, Pa.
Icken Model Locomotive Co., Palisades Park, N. J.
International Models, 354 W. 55th St., New York, N. Y.
J-C Models, 385 E. 13th St., Brooklyn, N. Y.
K & W Shop, 44 Marden St., Cranston, R. I.
Lafayette Model Co., P. O. Box 1932, Paterson, N. J.
Laconia Industries, Inc., Laconia, N. H.
Lange's Model Supplies, 75 E. Adams St., Chicago, Ill.
Lang-Cincinnati Cars, 902 Bank St., Cincinnati, O.
Lionel Corp., 15 E. 26th St., New York, N. Y.
Little Engines, Box 15, Wilmington, Calif.
Rollin Lobaugh, 1179 Howard St., San Francisco, Calif.
Mantua Metal Products Co., Woodbury Heights, N. J.
Megow's, Howard & Oxford Sts., Philadelphia, Pa.
Metzger Engineering Co., 315 Market St., Harrisburg, Pa.
Miniature RR. Equipment Co., 3518 Sunnyside Ave., Philadelphia, Pa.
Model Railroad Exchange, 26 Crescent Blvd., Collingswood, N. J.
Model Railroad Laboratories, Box 123, Jamestown, N. Y.
Model Railroad Shop (H. Owen), 292 Vail Ave., Dunellen, N. J.
Model Craft Co., 4218 Osage Ave., Philadelphia, Pa.
Eugene V. Montross, 239 Franklin St., Reading, Pa.
Paul Moore, Box 187, Adrian, Mich.
Nason Railways, Inc., P. O. Box 9, Mt. Vernon, N. Y.
M. Dale Newton Co., 2303 Hyde Park Blvd., Los Angeles, Calif.
O Pullmans, 109 W. 19th St., New York, N. Y.
Parmele & Sturges, Inc., 51 Crown St., New Haven, Conn.
Picard Novelty Co., Westerly, R. I.
Pittman Electrical Developments Co., 127 Nippon St., Philadelphia, Pa.
Pomona Valley Model Supply, 5th and Firey, La Verne, Calif.
Pratt's Models, 157 92nd St., Ozone Park, N. Y.
The Roundhouse, 1301 N. Catalina, Hollywood, Calif.
Scale-Models, 1516 S. Wabash Ave., Chicago, Ill.
Scale Model Railways (Division of Megow), Huntington, Ind.
The Spot Hobby Shop, 115 W. Fayette St., Baltimore, Md.
G. D. Stock, 40 W. Mt. Airy Ave., Philadelphia, Pa.
Vanden Boom, 38th & Broadway, Kansas City, Mo.
Gordon Varney, 215 W. Ohio St., Chicago, Ill.
Wm. K. Walthers, Inc., 231 E. Erie St., Milwaukee, Wis.
Westbrook Co., Hasbrouck Heights, N. J.

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